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VOLUME 27 NUMBER 9

The Journal

OF THE

AMERICAN DENTAL ASSOCIATION

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Control of Dental Pain—*Gabel*

Making Small Castings—*Crawford*

Denture Rubber—*Sweeney and Caul*

Dental Uses of Sulfanilamide—*Edwards*

Unerupted Canines—*Mershon and Gunter*

Positive Mechanical Bridge Fixation—*Phillips*

Phlegmons of Face—*Lederer and Fishman*

Partial Denture Construction—*Applegate*

Local Factors in Dental Caries—*Hanke*

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STUDIES ON THE LOCAL FACTORS IN DENTAL CARIES. I. DESTRUCTION OF PLAQUES AND RETARDATION OF BACTERIAL GROWTH IN THE ORAL CAVITY

By MILTON THEO. HANKE,* Ph.D., Chicago, Ill.

INTRODUCTION

DENTAL caries is a disease in which the tooth structure, and primarily the dental enamel, is decalcified. That this is a fact has been amply demonstrated both chemically and microscopically by G. V. Black,[1] W. D. Miller[2] and J. Leon Williams.[3] We[4] have shown that the decalcified enamel margins, described by Black and Williams, are more easily penetrated by the roentgen rays than is the adjacent sound tooth structure. Roentgenologists, moreover, agree that caries starts as a region of roentgenologic rarefaction.

Black, Miller and Williams were certain that the decalcifying agent is an acid produced by the action of bacteria on carbohydrates. Miller proved that numerous bacteria, capable of producing acid from carbohydrates, are always present in the oral cavity. He also showed that litmus paper turns red when placed in contact with carious dentin, and he was able to obtain a test for lactic acid from the aqueous extract of a carious tooth. Although this demonstration was sufficient to convince Black and Williams and most other investigators, it is not very convincing to a chemist, because litmus changes color at a pH of about 7, and the test used by Miller is not specific for lactic acid. One of the weak links in the chain of evidence in support of the chemicobacterial theory of dental caries is the failure to demonstrate a sufficient degree of acidity in a carious lesion to account for that lesion.

Dental caries does not usually attack the tooth as a whole. The carious lesions are most likely to occur in certain well-

*In collaboration with the Members of the Chicago Dental Research Club.

Read before the Section on Therapeutics, Pathology and Research at the Seventy-Sixth Annual Midwinter Meeting of the Chicago Dental Society, February 14, 1940.

recognized regions. It is necessary, therefore, to explain why bacteria select these places in which to produce acid from carbohydrate; and this has led to the theory of the dental plaque and to the recognition of regions of stagnation. Dental caries usually, if not always, occurs in places that are not kept clean and that are not subjected freely to the action of saliva. Tooth surfaces that are not cleaned mechanically are soon covered with a more or less thick film of a white adherent material, to which Williams assigned the name dental plaque. Williams showed that the plaque consists of a thick porous mat of filamentous micro-organisms (some of which are true fungi) interwoven much like the fiber in a piece of blotting paper and capable of absorbing considerable fluid. Of this plaque, Williams said:

This mass of fungi is so dense and adhesive as to make it highly improbable that the enamel is affected, except in rare and special instances, by any acid other than that which is being excreted by the bacteria at the very point where they are attached to the enamel. The thick, glutinous-like mass of fungi also prevents the excreted acid from being washed away, so it exerts its full chemical power upon the calcific tissue.

G. V. Black,[1] in referring to these studies by Williams, said:

. . . he had included all manner of material that contained micro-organisms . . . going wide of the line of those forms of fungi known to produce caries. He seems also to have included deposits through which water would run so easily that they would be no bar to washings by the saliva. Such coatings are found plentifully over the surfaces of teeth of immune persons, and also in others where there is no decay of the enamel. Careful study shows that many kinds of deposit upon the teeth present similar appearances, when seen in microscopic sections, to those produced by gelatinous plaques, and yet seem to have no influence whatever in the localization of caries. A plaque, to have any considerable effect, certainly must have sufficient firmness in the moist state to act more or less perfectly as a dialyzing membrane [page 129] . . . Neither will loose aggregations of saprophytic micro-organisms, or of *Leptothrix buccalis,* or the leptothrix of Vignon, or other harmless varieties which may form thick masses over the teeth, through which water will run as freely as through a sieve, have any influence favoring the production of caries. The covering must be of a kind that will protect from free washing by the fluids in the mouth, and in and under which the caries fungi will grow and produce acid

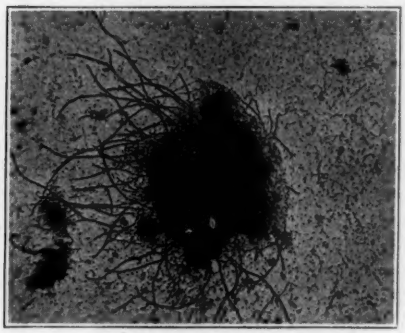

Fig. 1.—Unretouched microphotograph of plaque material obtained from human teeth, consisting largely of mass of filamentous micro-organisms intermeshed in matlike structure, the interstices of which are more or less filled with bacteria and occasional epithelial cells. The microscopic structure of plaques can be studied more readily after the original dense mass is disrupted by shaking vigorously with water in a small glass jar. (See also Figs. 2-6. Figure 3 shows the original structure.)

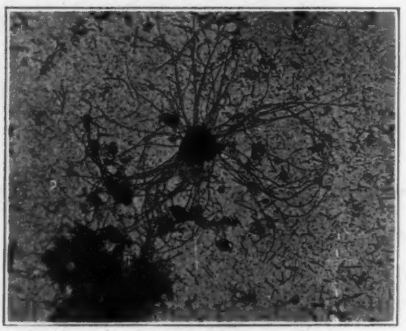

Figure 2.

fermentation. This may be so thin and so transparent that the teeth may appear clean and yet afford an effective protection against the too free dissipation of the acid products of fermentation. [Page 111.]

These statements by Black have led to a great deal of speculation and have, for many years, diverted attention from the facts discovered by Williams. That this subject was far from clear even in 1932 is evident from the following quotations taken from an article by Enright, Friesell and Trescher[5]:

Thus far it appears that only Williams, who first applied the term plaque, has made important progress in this phase of research. . . . The varieties of terminology to define plaques such as bacterial, gelatinoid, mucinous and acid-mucin plaque that have appeared in the literature might lead one to believe that some specific information concerning plaques has been contributed. However, the reports on the nature of the plaque, with but few exceptions, appear to be speculative. . . . The nature of the plaque has been so puzzling that our study of this subject, which is still under way, has failed to add any new knowledge to this subject.

It is evident, therefore, that, although plaques are generally recognized as being in some way associated with dental caries, a difference of opinion exists as to their nature and the way in which they hasten the carious process. That plaques can absorb and retain sugar and that a degree of acidity sufficient to decalcify dental enamel can be produced in the plaques on teeth in the mouth has not, heretofore, been proved. If plaques consist largely of living micro-organisms, it should be possible to remove them with a suitable germicide; and that this can be done has not previously been demonstrated. If the plaque, on the contrary, is a lifeless membrane consisting, possibly, of protein, it should be possible to remove it with a digestive ferment. We have not, thus far, been able to remove plaques with enzymes.

Figure 3.

EXPERIMENTAL PHASE

SECTION 1: THE NEUTRALIZING POWER OF DENTAL ENAMEL

Dental enamel is slightly soluble in distilled water, and readily soluble in

dilute acids. It partially neutralizes the acids as it dissolves in them, thus tending to maintain a pH of between 4.2 to 5.6. As the mixture of bacteria that are present in any mouth are not killed by this degree of acidity, the bacteria can slowly continue to make more acid, which then dissolves more of the tooth structure. The tooth, by neutralizing acids produced by the oral bacteria, actually helps to keep the bacteria alive and thus hasten its own destruction.

The facts as stated above for the action of acids on dental enamel can be determined as follows:

Mix 0.1 gm. of 300-mesh dental enamel (free from dentin) with 20 cc. of distilled water in a sterile 1-ounce jar equipped with a gas-tight screw cap. Agitate frequently during a three-hour period. Allow the powder to settle. Bring the perfectly dry electrodes of a Beckman pH meter into the liquid and determine the pH. Add 0.1 normal hydrochloric acid in 1.0-cc. portions (or less), agitate frequently during a three-hour period and, after each addition, determine the pH of the liquid with the Beckman pH meter.

The following series of pH values are thus obtained regardless of the origin of the enamel:

The first figure is that obtained by suspending dental enamel in distilled water. The other figures are obtained after adding 0.1 normal hydrochloric acid in successive 1-cc. portions to the suspension: 7.7-8.0; 5.65; 5.16; 4.84; 4.73; 4.60; 4.50; 4.44; 4.34; 4.20; 4.05; 3.90; 3.53. The enamel is almost completely dissolved at pH 4.20, after the addition of 9 cc. of acid.

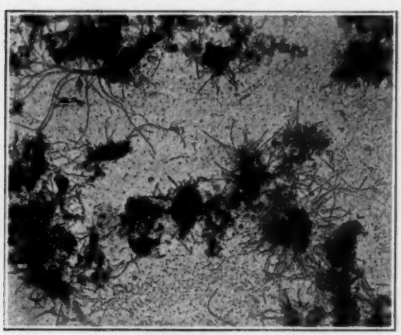

Figure 4.

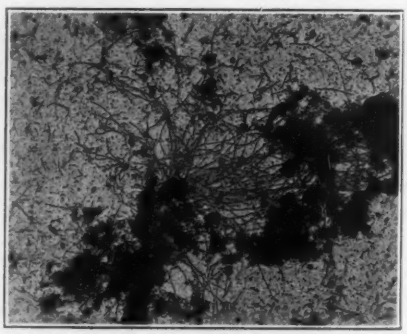

Figure 5.

SECTION II: THE PRODUCTION OF ACID BY ORAL BACTERIA

We have shown in a previous report[7] that a four-hour incubation of saliva (containing some sugar) may depress the pH to 4.5. Further studies have shown that a pH of from 4.2 to 4.4 is usually obtained when saliva, regardless of source (as long as it contains sugar), is incubated for six hours.

It is evident, therefore, that the mixture of bacteria that can be found in any mouth is capable of producing a degree of acidity sufficient to dissolve dental enamel completely.

SECTION III: THE REACTION OF A CARIOUS LESION

That litmus paper turns red when it is brought in contact with the material in a carious lesion is common knowledge. While that test shows that a carious lesion is acid in reaction, it does not prove that the degree of acidity is sufficient to dissolve tooth substance.

When a small drop of a yellow alcoholic solution of methyl red is brought in contact with superficially dried carious lesions in teeth in the mouth, all of the carious material invariably becomes dark red, this indicating that the pH of the carious material is 5 or below. This is a sufficient degree of acidity to dissolve the inorganic constituents of the teeth.

SECTION IV: THE DEVELOPMENT OF A DEGREE OF ACIDITY IN THE ORAL CAVITY SUFFICIENT TO DISSOLVE DENTAL ENAMEL

There are areas on the teeth in nearly any mouth where a stain such as Bismarck brown will reveal the presence of

Figure 6.

dental plaques. When a small drop of an alcoholic solution of methyl red is brought in contact with a dental plaque, the latter sometimes becomes red (pH 5 or lower) or yellow (pH above 5), thus indicating that dental plaques, as we find them in the average mouth, may or may not contain sufficient acid to injure enamel.

A test conducted upon twelve members of the Chicago Dental Research Club showed acid plaques (pH 5 or below) in six cases, alkaline plaques (pH above 5, but not necessarily really alkaline) in five cases and no plaques at all in one case.

All of these persons then ate a cube of sugar. The same indicator test conducted one hour later showed that the plaques were stained red in all cases, the result indicating that they contained, at this time, sufficient acid to be at a pH of 5 or below.

From this, we conclude that plaques menace the teeth because sufficient acid can develop in them (especially after eating carbohydrates) to dissolve dental enamel.

SECTION V: THE NATURE AND SIGNIFICANCE OF THE DENTAL PLAQUE

Macroscopic and microscopic examinations of dental plaques obtained from the teeth of several hundred people show that:

1. The dental plaque is constructed exactly as stated by Williams. (Figs. 1 to 6.)

2. Innumerable bacteria and some epithelial cells can always be found associated with the filamentous micro-organisms.

3. Plaques on the teeth in regions of stagnation, in the case of habitual candy eaters, are often heavily impregnated with syrup even half an hour after the candy has been eaten. Such plaques are strongly acid in reaction, not infrequently having an odor resembling that of butyric acid, and they cannot be dried on a glass slide until after the syrup has been removed by washing with water.

4. Plaques adhere tenaciously to the teeth, almost as if they were attached by some sort of life process. Usually, they cannot be removed, even from accessible places, with a softened or soft bristle toothbrush, and most people cannot remove them from between the teeth with dental floss. They can be removed mechanically with a hard bristle brush; by the use of a dentifrice that contains chalk, gypsum, dicalcium phosphate, calcium pyrophosphate or sodium metaphosphate on a soft bristle brush, or by instrumentation.

TABLE 1.—DATA OBTAINED WITH TEST PREPARATIONS

Material Used	Irritates Mucous Membranes	Interval After Using Hours	Bactericidal Effectiveness Per Cent
p-chlor-m-xylenol-(0.2%)	Yes	1	0
1, 3, 6 tribrombetanaphthol (0.1%)	Yes	1	0
3 brom 4 hydroxydiphenyl (0.1%)	Yes	1	16
Liquor antisepticus U.S.P. VIII full strength	Slightly	1	0
Liquor antisepticus N.F. full strength	Yes	1	45
Aminodiphenyl nitrate (0.1%)	Yes	1	0
Colloidal sulfur, aqueous 5%	No	1	0
Calcium sulfate in toothpaste 5%	No	1	0
Sodium thiosulfate in 15% glycerol 5%	No	1	0
Chloramine T solution in water 0.3%	Yes	1	92
		2	95
Sodium dichlorsulfamid benzoate (pantosept.), 0.3% solution in water	Yes	1	67
		1	92
		2	14
Sodium perborate solid	Yes	1	89
		1	83
		9	41
Hydrogen peroxide 3% solution as purchased	No	1	77
		1	100
		1	67
		2	21
Formaldehyde solution in water 0.1%	No	1	70
		1	46
		10	16
Formaldehyde 0.1%, zinc chloride 0.25% in water	Yes	1	46
		1	62
		9	41
Auramine in water 0.02%	No	2	42
		2	14
Safranine in water 0.01%	No	1	27
		3	15
		9	0
Rivanol 0.033% in water	No	1	100
		2	85
In 20% glycerol		3	86
Eucupine in 12% glycerol 0.02%	No	1	28
	No	1	54
Vuzin in 12% glycerol 0.02%	Yes	1	54
	Yes	1	18
		2	25
		2	0
In 12% glycerol 0.05%	Yes	1	93
		1	75
Magnesium oxide as powder	Yes	2	0
		9	0
Milk of magnesia U.S.P. full strength			
Zinc acetate in 15% glycerol 0.25%	No	1	0
	No	1	0

Material Used	Irritates Mucous Membranes	Interval After Using Hours	Bactericidal Effectiveness Per Cent
Zinc lactate in 15% glycerol 0.5%	Yes	1	0
	Yes	1	0
Zinc salicylate in 15% glycerol 0.25%	No	1	0
	No	1	0
Aluminum acetate in 15% glycerol 0.04%	Yes	1	60
		1	75
	Yes	1	9
		1	27
Aluminum formate in 15% glycerol 0.25%	Yes	1	16
Aluminum oxide milled in a toothpaste 10%	No	1	66
		1	50
	No	1	27
		1	0
Copper citrate in water 0.1%	No	2	90
		2	93
		9	93
		9	66
		9	33
Nickel sulfate in 15% glycerol 1.0%	No	2	100
		2	100
		4	100
		4	100
		9	0
		9	0
		9	0
		9	0
Phenyl boric acid			
0.05%	No	2	0
0.25%	Paralyzes tongue	2	0
Triphenyl tin nitrate in 15% glycerol 0.1%	Severe slough	2	0
		9	0
Phenylmercuric nitrate in 15% glycerol 0.02%	No	2	100
		5	100
		9	100
		11	92
		15	66
	No	9	75
		9	92
		9	100
		9	84
		9	33
0.01%		9	0
		9	0
Tolylmercuric nitrate in 15% glycerol 0.015%	No	2	100
		9	66
Metaphen	No	1	100
Purchased 0.1% solution diluted with 4 parts water		2	75
		9	25
Merthiolate	No	2	92
Purchased 0.1% solution diluted with 4 parts of water		2	50
		9	0
		9	0

5. A thin, but fairly tenacious growth of plaques can be demonstrated on teeth, in most mouths, in from twenty-four to thirty-six hours after all plaques have been removed by instrumentation.

6. Plaques are living structures that grow on and adhere tenaciously to the tooth surfaces. They can be found on the teeth in nearly all mouths regardless of the dental condition. They constitute a menace to the teeth because they always contain micro-organisms that can rapidly convert carbohydrates into acids, thus developing a degree of acidity, in the plaques, that can destroy dental enamel.

7. Plaques are less apt to become acid in reaction when they are kept moist with saliva, because even a poorly buffered saliva will neutralize some acid and give some protection. Dental caries seldom occurs, therefore, in the parts or surfaces of teeth that are bathed in saliva, even though plaques are present. Plaques are most apt to become acid in reaction in so-called regions of stagnation, because saliva does not penetrate these places readily or frequently.

8. A destructive degree of acidity develops rapidly and is maintained, perhaps constantly, when the saliva is poorly buffered. This is the case with persons who are highly susceptible to dental caries.

SECTION VI: THE EFFECT OF PROTEOLYTIC ENZYMES ON PLAQUES AND ON DENTAL CARIES

It has been generally assumed that plaques adhere to the teeth because they contain a sticky protein. If this were true, the use of a toothpaste or a liquid that contains 2 per cent of pancreatin or papain should remove the plaques. Studies made on twenty-five people have shown, however, that this is not true.

Pastes, with a dicalcium phosphate or chalk base, to which papain or pancreatin has been added, do, however, almost invariably have a healthful effect upon the soft oral tissues. Necrotic tissue and dead epithelial cells disappear rapidly and the mucous membranes look pink and healthy. The observations also showed that small superficial cavities take on a white appearance, and the teeth themselves become whiter. Extragingival calculus deposits may (1) become softened and slowly disappear or (2) become progressively loosened from the teeth, chip off in pieces and finally disappear. Dental caries was not arrested in one case in which a pancreatin-dicalcium phosphate paste was used for six months.

SECTION VII: THE EFFECT OF FUNGICIDES ON PLAQUES

Mercury, copper, silver, nickel and zinc salts are among the best of the fungicidal agents. Mercury, copper and silver are effective when present in low concentration, and these three metals, or their salts, have been used extensively by dentists in combating dental caries. Copper cement, for example, has long been used as a filling material, especially for deciduous teeth. Although unsightly, it prevents further decay of tooth areas contiguous to the filling, as was recognized fifty years ago.[2]

A 0.1 per cent solution of a suitable copper salt (e.g., copper citrate), used as a mouthwash and retained for two minutes, destroys the cohesive and adhesive character of the plaque and apparently kills the filamentous micro-organisms. Plaques and *materia alba* disappear from the teeth after a few rinsings. The solution, however, has a disagreeable persistent metallic taste, which tends to produce nausea after the liquid has been used twice a day for a few days. This is especially true in people who smoke. The teeth of smokers become discolored and have a dull bluish brown appearance.

Copper salts are effective and probably not poisonous in these concentrations, but their use is impractical.

TABLE 2.—BACTERICIDAL EFFECTIVENESS OF SOLUTION 58

Patient	No Treatment			Four Hours After Solution 58 (Hanke)			
	Before Incubation	After Incubation for 4 Hours	Acid Produced by Bacteria Cc. 0.1 N HCl	Before Incubation	After Incubation for 4 Hours	Acid Produced by Bacteria Cc. 0.1 N HCl	Bactericidal Effectiveness
	pH	pH		pH	pH		Per Cent
D.W.	7.5	5.3	2.2	7.8	7.72	0.0	100
E.E.	7.1	5.6	0.8	7.25	7.3	0.0	100
N.K.	8.0	6.4	0.8	7.6	7.6	0.0	100
A.S.	7.9	5.82	1.0	7.41	7.38	0.0	100
E.B.	8.23	6.6	0.7	8.0	8.0	0.0	100
G.N.	7.6	4.95	0.7	7.65	7.68	0.0	100
A.L.	7.13	5.93	0.8	7.7	7.65	0.0	100
O.C.	8.65	6.93	0.6	8.2	8.12	0.0	100
J.P.	8.13	6.6	0.4	8.6	8.45	0.0	100
C.M.	8.2	4.6	0.8	8.16	8.2	0.0	100
K.B.	6.85	4.4	1.0	7.6	7.45	0.0	100
H.C.	7.0	4.65	1.1	7.2	6.8	0.05	96
L.B.	8.04	5.4	1.1	7.5	7.23	0.1	91
H.B.	7.8	6.5	1.0	7.4	7.2	0.1	90
W.C.	6.85	5.02	0.5	6.7	6.6	0.05	90
A.J.	7.06	5.75	0.8	7.62	7.4	0.1	87
J.B.	7.53	5.3	1.4	7.41	7.0	0.2	85
F.L.	7.0	5.0	1.3	7.4	7.0	0.2	85
M.B.	8.03	5.45	1.3	8.14	7.3	0.2	85
S.K.	7.67	6.3	1.3	7.7	7.2	0.2	85
N.I.	8.15	6.7	1.5	7.7	6.63	0.3	80
B.E.	8.52	6.27	1.0	8.3	7.53	0.2	80
J.M.	8.07	4.8	1.1	7.3	6.5	0.3	73
D.B.	7.0	5.7	1.5	7.43	6.8	0.4	73
G.M.	7.3	4.35	1.5	7.43	6.7	0.4	73
B.U.	7.23	4.6	1.4	7.3	6.6	0.4	71
W.B.	7.4	6.1	2.0	7.45	6.6	0.8	70
D.H.	7.1	4.7	1.0	7.5	6.52	0.3	70
S.P.	8.6	6.4	0.9	8.47	7.2	0.3	67
F.B.	7.37	4.92	1.7	8.35	6.65	0.6	65
N.O.	8.15	5.13	1.6	8.1	6.7	0.6	63
H.I.	7.82	5.4	1.3	8.6	6.8	0.5	61
A.J.	7.1	5.25	1.1	7.35	6.6	0.5	55
J.F.	7.26	4.9	0.9	7.38	6.52	0.4	55
A.A.	7.5	6.1	1.0	7.35	6.72	0.5	50
R.P.	7.8	4.9	1.4	7.8	6.5	0.7	50
W.A.	7.7	5.65	1.2	7.8	6.7	0.6	50
G.L.	7.5	6.47	0.9	7.55	6.82	0.5	44
F.B.	7.4	5.5	1.8	7.28	6.1	1.2	33
J.L.	8.2	6.08	1.0	8.0	6.5	0.7	30
				Nine Hours After Solution 58 (Hanke)			
M.H.				6.65	6.45	0.2	84
M.H.				6.5	5.9	0.6	50
C.H.				6.72	6.5	0.2	84
C.H.				7.05	6.5	0.4	66
C.H.				6.7	6.05	0.6	50

Although silver salts cannot be used in a mouth rinse because of their taste, causticity and discoloring properties, dentists have for years painted susceptible areas on teeth with concentrated solutions of silver salts. A deposit of black colloidal silver is soon obtained that may penetrate and discolor porous enamel to a considerable depth. It has been observed that dental caries can, in some cases, be arrested by this treatment.

Nickel sulfate has a sweet, slightly astringent, not unpleasant taste. Its use as a mouthwash (1 per cent) or in a toothpaste (2.5 per cent) leads to a rapid disappearance of plaques from the teeth and renders the mouth practically sterile for periods up to four hours. A bluish black discoloration, which is not easily removed by brushing, appears on the teeth of people who smoke. A persistent unpleasant metallic taste develops after about a week of constant use (twice daily). A marked drowsiness and inability to think clearly develops during the second week, soon followed by the more violent symptoms of nickel poisoning (vomiting, diarrhea and retention of urine). Nickel salts, therefore, cannot be used.

Zinc is an effective fungicide when it is present as acetate or as freshly precipitated hydroxide. In solution (0.25 per cent) or in a toothpaste (0.5 per cent), zinc acetate is mildly astringent and it destroys the cohesive and adhesive properties of the plaque as well as the filamentous micro-organisms in many mouths. Plaques disappear from the teeth after the mouth has been rinsed a few times with the solution or after a few applications of the paste to the teeth, even though the teeth are not brushed. Zinc does not appear to be poisonous when used in the mouth. It does not discolor the teeth, and its use does not give rise to a metallic taste. It is an ideal material except for the fact that (1) it is not effective in all cases; (2) solutions or pastes that contain zinc acetate appear to lose their effectiveness with age, and (3) zinc acetate does not show any significant bactericidal action in the mouth.

Mercury salts are effective fungicides and germicides. Miller,[2] and more recently Kolmer,[8] have advocated the use of mercuric chloride and of organic mercurials, respectively, as a mouthwash or in a toothpaste. Miller wished to destroy bacteria and thus stop tooth decay, and Kolmer was attempting to cure gingivitis.

The organic mercurials are interesting because of their low toxicity. A 0.02 per cent solution of almost any of these that are now commercially available can serve as an oral antiseptic. Thick plaques are, moreover, promptly loosened and may actually peel off of the teeth in small pieces shortly after the mouth is rinsed with one-third of a fluid ounce of such a solution. Organic mercurials are not irritating to the oral mucous membranes. Gingivitis usually disappears in a few days except in those regions contiguous to calculus, and even here the tissues shrink to nearly normal. The consistent use of such preparations would, presumably, stop dental caries; but there

TABLE 3.—TIME DURING WHICH SOLUTION 58 HAS BEEN USED

3 Months	6 Months	9 Months	1 Year	1.5 Years	2 Years	2.5 Years	3 Years
3*	3*	1	6*	3*	17*	7	1*
3	5		15	6	20		5

*Patients using solution for whole time indicated. In the other cases, the solution was used most of the time.

are certain objections to their constant use, such as amalgamation with gold inlays; a metallic taste that may, in time, become nauseating, and a bluish black discoloration of the teeth, especially in the case of people who smoke. An organic mercurial that we have found to be free from these objections is discussed in Section IX.

The findings cited above show that plaques disappear from teeth rapidly when the mouth is rinsed with a solution that is fungicidal. We feel justified, therefore, in concluding that plaques are essentially living membranes and that only while alive do they adhere to teeth.

SECTION VIII: INHIBITION OR DESTRUCTION OF BACTERIA IN THE MOUTH

All mouths, and therefore all samples of saliva, contain many bacteria and this mixture of micro-organisms rapidly converts carbohydrates into acids. It would be generally conceded, we believe, that the incidence of the more common dental diseases, such as dental caries, gingivitis and pyorrhea, could be greatly reduced if some means were known for reducing the number or the vitality of the oral bacteria. A large variety of antiseptics are available today, but the usual test tube methods for determining their bactericidal effectiveness is not indicative of what these preparations will actually do in the mouth. We have studied this matter during the past ten years and wish, at this time, to present a simple quantitative method of determination that gives results in harmony with clinical observations.

The bacteria on the surfaces of the oral tissues are identical with those in the mixed oral fluid that we call saliva. In fact, it is questionable whether bacteria even grow directly on healthy soft oral tissues because of the ever-changing layer of fluid with which such tissues are covered. The bacteria grow in this liquid on the tissues and in the oral fluids rather than on the tissues themselves. That they also grow in the liquid incorporated in plaques is of importance as a cause of dental caries; but these bacteria have little effect upon the total bacterial count in the oral cavity. It follows, therefore, that the bacterial properties of saliva itself simulate bacterial conditions elsewhere in the mouth and on the oral tissues.

The number of bacteria present in saliva can be reduced 50 per cent by rinsing the mouth thoroughly with water before the saliva is collected; but this is of no practical significance because the saliva will still contain from one to twenty-five million bacteria per cubic centimeter and the original count will be reestablished within thirty minutes. Any antiseptic mouthwash (so-called) may, therefore, reduce the actual number of viable bacteria in saliva by as much as 90 per cent and still be of little clinical value because of the tremendous number remaining and because more are rapidly produced. Determination of the number of viable bacteria present in saliva after the mouth has been rinsed with an antiseptic has, therefore, no clinical significance, and the method, to be of clinical value, must determine what the residual bacteria may do rather than the number that are present.

We have been interested primarily in the rate of acid production by the oral bacteria because this is a vital factor in dental caries. To be of maximum value in inhibiting this disease, an antiseptic must retard or prevent acid production for hours (preferably overnight, or nine hours), and the degree of acidity that may develop in saliva in four hours of incubation should not be dangerous to dental enamel (pH 6 or above). (The saliva of immune persons has been found to have a pH of 6 or above after incubating for four hours). The antiseptic must not be irritating to the soft oral tissues and must not be poisonous in such amounts as are used daily for a period of at least a year.

SECTION IX: METHOD FOR EVALUATING ORAL ANTISEPTICS

Collection of Control Specimen.—A piece of sweetened gum is chewed and all of the liquid that collects in the mouth (including the sweet gum extract) is expectorated into a sterile 30-cc. screw cap jar, until about 25 cc. has been collected. The mixed specimen is divided into two approximately equal parts, one-half to be incubated for four hours. The other half is treated with a fast-acting germicide, such as parachlormetaxylenol, and set aside in a refrigerator.

Use of the Oral Antiseptic.—From 5 to 10 cc. of the oral antiseptic whose effectiveness is to be tested is introduced into the mouth and retained there, with constant agitation, for two minutes. The liquid is expectorated, but the mouth is not rinsed. Saliva is collected in a sterile jar one, two, four or nine hours after the oral antiseptic has been used. This 25-cc. specimen is also divided into two approximately equal parts. One half is incubated for four hours and the other half is sterilized as before and placed in a refrigerator.

Titration of the Samples, No Antiseptic Used.—The pH of the incubated saliva is determined; exactly 10 cc. of the sterilized portion of the sample measured into the glass potentiometer cup, and the pH determined with a Beckman pH meter. A 0.1 normal hydrochloric acid solution is added in 0.1-cc. portions until the pH is identical with that of the incubated portion of saliva. The resulting figure is a direct index of the ability of the bacteria to produce acid in the given sample of saliva.

Titration of the Samples After Using the Oral Antiseptic.—The procedure is exactly as described above, using the specimen obtained after the mouth was rinsed with the oral antiseptic.

Designation of Results.—Bacteriostatic (or bactericidal) effectiveness is conveniently expressed in percentage. Assume, for example, that 10 cc. of a normal sample of saliva, when incubated for four hours, becomes sufficiently acid to reduce the pH to 5 and that it has been shown further that 1.0 cc. of 0.1 normal hydrochloric acid solution has to be added to the sterilized portion of this saliva to reduce the pH to 5.0. The oral bacteria in this case produce an acidity equal to that of 1.0 cc. of a 0.1 normal hydrochloric acid solution.

The incubated portion of the saliva specimen collected from the same person four hours after rinsing of the mouth with a 1:5,000 solution of phenylmercuric nitrate had a pH of 6.5. The sterilized portion of this sample had a pH of 7, and the addition of 0.1 cc. of 0.1 normal hydrochloric acid solution reduced the pH to 6.5. The bacteria in the saliva collected four hours after rinsing of the mouth with this phenylmercuric nitrate solution produced only one-tenth as much acid as in the specimen taken just prior to the use of the mouthwash. The bactericidal efficiency (B.E.) is therefore 90 per cent for four hours.

The following materials of known composition were tested by this method for their bacteriostatic (or antiseptic) action in the oral cavity:

Parachlormetaxylenol (0.2 per cent); 1, 3, 6 tribrombetanaphthol (0.1 per cent); 3 brom-4-hydroxydiphenyl (0.1 per cent); liquor antisepticus U.S.P. VIII; liquor antisepticus N.F.; aminodiphenyl (0.1 per cent); colloidal sulfur (5 per cent); calcium sulfite (5 per cent); sodium thiosulfate (5 per cent); chloramine T. (0.3 per cent); sodium, dichlorsulfamid benzoate (0.3 per cent); sodium perborate, powder; hydrogen peroxide (3 per cent); formaldehyde (0.1 per cent); auramine (0.02 per cent); safranine (0.01 per cent); rivanol (0.033 per cent); eucupine (0.02 per cent); optochin (0.02 per cent); vuzin (0.02 and 0.05 per cent); zinc acetate (0.25 per cent); zinc lactate (0.5 per cent); zinc salicylate (0.25 per cent); aluminum acetate (0.04 per cent); alu-

minum formate (0.25 per cent); aluminum oxide (10 per cent in toothpaste); copper citrate (0.1 per cent); nickel sulfate (1.0 per cent); phenyl boric acid (0.05 and 0.25 per cent); triphenyl tin nitrate (0.1 per cent); phenylmercuric nitrate (0.02 per cent); tolylmercuric nitrate (0.015 per cent); metaphen (0.02 per cent), and merthiolate (0.02 per cent).

Representative figures obtained with these preparations are given in Table 1. A detailed discussion of the results cannot be given here.

SECTION X: A PRACTICAL ORAL ANTISEPTIC THAT DESTROYS PLAQUES AND THAT MAY ARREST OR PREVENT DENTAL CARIES

The search for an oral antiseptic that will also destroy plaques and thus possibly supply a means for the practical control of dental caries revealed the organic mercurials as superior agents. Extensive studies demonstrated, however, that the more readily available organic mercurials could not be used continuously because of the objections previously cited. Our aim, therefore, was to find an organic mercurial that would be free from these objections.

Frank C. Whitmore prepared a series of organic mercurials in 1926,[9] one of which, sodium p-hydroxymercuribenzoate ($HO\text{-}Hg\text{-}C_6H_4\text{-}COONa$) seemed ideal for our purpose, from a chemical point of view. The product is readily soluble in water, with a slightly alkaline reaction, and is quite stable under conditions such as would exist in a solution or in the human body. The carboxyl group in the para position stabilizes the carbon-hydrogen attachment and should serve further to enhance elimination of any unchanged mercurial through the kidneys. The product has a bitter taste; but this is not apparent when a mouthwash that contains it is compounded as follows:

SOLUTION 58 (HANKE)

To 4.0 gal. of distilled water add 2,880 cc. of U.S.P. glycerol, 30 cc. of 1.0 normal sodium hydroxide, 90 gm. of C.P. sodium acetate, 450 cc. of a 1 per cent solution of sodium para hydroxymercuribenzoate, 30 cc. of a 10 per cent solution of oil of peppermint in alcohol. Dilute with distilled water to 5 gal.

To prepare the 1 per cent mercurial solution for use in the above formula, mix 10 gm. of sodium parahydroxymercuri-benzoate, 10 gm. C.P. sodium acetate and 5 cc. of 1.0 normal sodium hydroxide with sufficient distilled water to make 1,000 cc. of the solution.

This solution is colorless and has a pleasant, sweet taste. A metallic taste does not develop even though the solution is used once or twice daily for prolonged periods. Amalgamation with gold fillings, etc., does not occur (chewing gum does not stick to the teeth). Smokers' teeth that are given ordinary home care do not become discolored. Plaques usually disappear from the teeth after a few rinsings and can always be removed easily with a soft bristle toothbrush or dental floss after one or two rinsings. The solution evidently destroys the cohesive and adhesive properties of the filamentous micro-organisms of which plaques are largely composed; the formation of new plaques is prevented, and *materia alba* deposits and simple gingivitis usually disappear after the solution has been used twice a day for a few days. The liquid is soothing rather than irritating.

The solution is not a powerful germicide. The so-called powerful germicides, that is the ones that kill quickly, also destroy living tissues and their use is conducive to gingivitis. The thought that oral antiseptics must contain powerful germicides to be of any value may have originated from the erroneous belief that liquids do not remain long in the mouth. We have shown that the presence of cane sugar can be demonstrated in the mouth for at least one hour after it has been eaten and that the sweet taste of solution 58, described above, also persists for from one to two hours after it has been used. This taste could obviously not persist if active bacteria were present because they

would quickly destroy the glycerol. This solution is probably as effective as it is because some of the organic mercurial stays in the mouth for quite a long time.

The practical effectiveness of solution 58 is shown in Table 2. The method used on the forty-five people is identical with that previously described in Section VIII. Ten cubic centimeters (one-third fluid ounce) was retained in the mouth for two minutes. The liquid was then expectorated. Saliva was collected just prior to, and four or nine hours after using the solution. A degree of acidity dangerous to dental enamel did not develop in any case during a four-hour incubation of the saliva even though the saliva was collected four or even nine hours after the mouthwash was used. This, together with the fact that the liquid demonstrably destroys and its use prevents the formation of plaques, would indicate that this solution affords a definite means of arresting or preventing dental caries, at least in a great number of cases.

SECTION XI: CLINICAL EXPERIENCES WITH SOLUTION 58

Solution 58 has been furnished to and used by ninety-five people, patients of the members of the Chicago Dental Research Club, of whom the dentists have records, in some cases, covering twenty or more years. These patients were instructed to use from one-fourth to one-third ounce of the solution once or twice daily, the liquid to be retained in the mouth for not less than two minutes each time. Table 3 shows how long and how consistently the ninety-five people have used the solution.

Any symptoms of mercury poisoning have been carefully watched for, but none have been observed in any of these people. It is believed that solution 58 has been used long enough by a sufficient number of people to show that it is not poisonous when used as directed. This is not surprising in view of the fact that one-third ounce of solution 58 contains only one-fiftieth grain of mercury, the major part of which is probably expectorated.

Patients who use solution 58 once or twice a day do not have plaques or *materia alba* on either the teeth or the gums, and the mouth is clean and free from the odor that so frequently accompanies a dirty mouth.

Gingivitis usually disappears in a few days except in those regions contiguous to calculus, and even here the tissue tends to shrink to nearly normal. Solution 58 has also been used in a few cases of acute ulcerative gingivitis with very encouraging results.

It has been used as an antiseptic preparatory to diverse types of oral operation and to prevent infection after extraction. Molt,[8] in speaking of this preparation, says:

> Even if there may be an unavoidable break in the aseptic regime (in surgery in the mouth), any lack of effort to maintain sterile operative procedure is inexcusable. Recent discovery of a mercurial bactericide the use of one dram of which for rinsing the mouth actually insures and maintains freedom from bacteria for four hours removes the last possible excuse for careless operative intervention.

Dental caries has been definitely arrested or ameliorated in fifteen patients who have used the solution consistently as indicated above, and who had always, heretofore, been highly susceptible to this disease. Sufficient time has not elapsed to make a definite statement with regard to other caries-susceptible patients who are now using solution 58.

SUMMARY

1. Dental enamel is a well-buffered material that is slightly soluble even in alkaline solutions. A high degree of acidity is not required to dissolve it completely, a pH 4.2 being sufficient.

2. The mixture of micro-organisms present in any specimen of saliva will

usually produce sufficient acid to lower the pH of the medium to from 4.2 to 4.4 in six hours' time if carbohydrate is present.

3. Plaques on teeth, in the mouth, may be either alkaline or acid in reaction toward methyl red, but they almost invariably become acid in reaction within half an hour after sugar is ingested (pH 5 or below).

4. Plaques on the teeth in regions of stagnation, in the mouths of habitual candy eaters, are often heavily impregnated with syrup even half an hour after candy has been eaten. Such plaques are strongly acid in reaction. They not infrequently have an odor resembling that of butyric acid, and they cannot be dried on a glass slide until after the syrup has been removed by washing with water.

5. Plaques consist predominantly of filamentous micro-organisms intermeshed in a matlike structure, the interstices of which are more or less filled with bacteria and occasional epithelial cells.

6. Plaques disappear from teeth that are given ordinary care if the mouth is also carefully rinsed once or twice daily with certain antiseptic solutions, the best of which are solutions of the organic mercurials. The most satisfactory results are obtained when these solutions are retained in the mouth for a period of two minutes. A 1 :5,000 solution of any of the organic mercurials now on the market is effective, but all, if used over a considerable period of time, have such undesirable effects as discoloration of the teeth, amalgamation with gold fillings, etc., and a metallic taste.

A 1 :5,000 solution of sodium para-hydroxymercuribenzoate has been found to be completely effective and entirely free from the foregoing objectionable effects.

7. Specimens of saliva collected two, four and sometimes even nine hours after the mouth is rinsed with a 1 :5,000 solution of one of the organic mercurials generate little or no acid when incubated for four hours (sugar present). It is possible, therefore, so completely to inhibit or destroy the acidogenic micro-organisms that they are no longer of significance.

8. Dental caries has been arrested in a number of people who had always been highly susceptible to this disease, by the conscientious use of a 1 :5,000 solution of sodium para-hydroxymercuribenzoate.

9. Gingivitis frequently disappears from mouths that are rinsed daily with this solution.

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DENTAL USES OF SULFANILAMIDE

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I. HISTORY

THE introduction of chemotherapy in the treatment of infectious diseases has had much to do with the control of virulent infections. The earlier workers in the field of empiric therapeusis used mercury in the treatment of syphilis and quinine in malaria solely on the basis of their known effect in the treatment of those afflictions. The first approach to a scientific appraisal of this problem was made by Ehrlich, with his work on the arsenic preparations and their application in the treatment of syphilis (1910). Without doubt, arsphenamine therapy has remained the greatest accomplishment of modern chemotherapy.

In 1908, Gelmo[1] introduced the compound para-aminobenzene sulfonamide (sulfanilamide), but apparently its great possibilities remained unrecognized. Domagk,[2] in 1935, published the results of his experiments with the drug, and gave to medical science a powerful weapon in combating disease.

II. THE LITERATURE

A cursory examination of medical literature reveals an abundance of material on sulfanilamide and its uses, indicating the extent to which investigators and clinicians are studying this drug; but a diligent search of the leading dental publications discloses that little has been accomplished in the application of sulfanilamide to the practice of dentistry.

A review of the literature of dentistry from January 1936 to the present (September 1939) reveals a total of eight articles on the uses of sulfanilamide in dental practice. The reason for the paucity of communications on this topic is a matter of conjecture. In all probability, investigators now conducting experiments do not have sufficient data accumulated to warrant definite conclusions, or, at best, can offer only preliminary reports.

The first use of sulfanilamide in the treatment of oral disorders is reported by Sinclair,[3] who, in April 1937, used it in treatment of a necrotic (dry) socket. In June of that year, Raper and Manser[4] used it in a case of postoperative cellulitis. Kanthak and Pickering[5] reported no favorable results from its use in one case of oral pemphigus and in one case of streptococcal stomatitis. Archer[6] stated that the use of sulfanilamide in the treatment of alveolalgia (necrotic or dry socket) reduced the time of treatment by 50 per cent. Adams[7] treated six root-canal cases with this drug, obtaining negative cultures in all except one case after one irrigation with a hot aqueous solution of sulfanilamide. Feldman[8] used sulfanilamide in a case of osteomyelitis of the mandible, with excellent results. Goldsmith[9] reported four cases of cellulitis, arising from involvement of mandibular third molars, that responded promptly to sulfanilamide therapy. The Council on Dental Therapeutics[10] of the American Dental Association has published a review of the uses, toxicity and dosage of this drug, but does not give specific recommendations as to dental applications.

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III. GENERAL CONSIDERATIONS

Originally, sulfanilamide was introduced as a chemotherapeutic agent in the treatment of infections due to hemolytic streptococci, with unusual success in such conditions as septicemia, erysipelas, peritonsillar abscess, puerperal fever, mastoiditis, streptococcic sore throat, meningitis and osteomyelitis. The spectacular results achieved from its administration in these cases encouraged clinicians to use sulfanilamide in nearly all types of infection. Its indiscriminate use as a cureall brought forth unnecessary condemnation of the drug, but clinical reports show that it is definitely beneficial in certain types of pneumococcic infections and is also of great value in the treatment of meningococcal and gonococcal infections and staphylococcal infections of the urinary tract.

Sulfanilamide is used empirically, and its exact mode of action is unknown. It is readily absorbed from the gastro-intestinal tract in from three to five hours, and is excreted almost wholly by the kidney. It can be administered orally or parenterally, the oral method being used more extensively.

The toxic reactions to sulfanilamide therapy are classified as mild, moderate and severe. The mild reactions are: nausea, anorexia, headache, vertigo, cyanosis, dyspnea, acidosis and general malaise. The moderate reactions are similar, but more intense, especially cyanosis and dyspnea. The severe reactions are: skin rash, tachycardia, numbness of hands and feet, fever, diarrhea and blood dyscrasia.

Loveman and Simon[11] reported on the cutaneous eruptions that sometimes follow the administration of sulfanilamide, and described a stomatitis that occurred on the mucous membrane of the lower lip, under the tongue and on the buccal mucosa. These lesions, which closely simulated the mucous patches of secondary syphilis, subsided promptly on the withdrawal of sulfanilamide, only to recur when treatment was resumed.

Contraindications to sulfanilamide are: 1. Renal or hepatic involvements. 2. A diet rich in sulfur. Sulfhemoglobinemia is apt to develop, with resulting cyanosis. 3. Use of hypnotics derived from aniline dyes.

One of the great dangers of sulfanilamide therapy is the opportunity for patients to indulge in self-medication, particularly those who may have been under recent treatment. Such instances of harmful results have been reported and measures have been proposed that would permit sulfanilamide to be dispensed only by prescription and under supervision of the physician.

The admonition must be given that sulfanilamide should never be administered systemically except by a physician who is well qualified and familiar with the use of the drug.

IV. DENTAL APPLICATIONS

Oral infections that are commonly presented to the dentist for treatment can be grouped in the following divisions:

(a) Infections around the gingivae.

(b) Infections arising from pulpal involvements.

(c) Infections subsequent to tooth removal or jaw injury.

Infections Around the Gingivae.—Gingivitis, pyorrhea and Vincent's infection are the principal involvements in this division. The low-grade infection usually present in gingivitis is best controlled or eliminated by palliative treatment and removal of the cause of the condition; e.g., calcareous deposits and irritating restorations. Sulfanilamide therapy has brought about no discernible improvement in pyorrhea cases, and apparently is valueless in controlling this condition, although some clinicians have reported favorable results with the topical application of sulfanilamide powder following gingival resection.

Sinclair[3] is emphatic in stating that he has found the drug of no value in the treatment of Vincent's infection.

It is evident, then, that gingival infections do not respond favorably to sulfanilamide therapy.

Infections Arising from Pulpal Involvements.—The use of sulfanilamide in the treatment of infected root canals is of such recent origin that little information is available as to its effectiveness. While the results of Adams are startling, much additional work will be necessary before conclusions can be drawn. Sawyer, in using very hot aqueous solutions of sulfanilamide in treating infected root canals, reported difficulty in keeping the sulfanilamide in solution.

Infections Subsequent to Tooth Removal or Jaw Injury.—Infections incident to tooth removal, or tooth or jaw disorders, present serious problems in control and treatment. It is in this field that the use of sulfanilamide, systemically as well as locally, in the treatment of oral infections has its greatest possibilities. The infections most frequently encountered are cellulitis, osteomyelitis and necrotic (dry) socket.

Cellulitis: Particularly distressing are the acute infections of the face, neck and floor of the mouth that have their origin in an infected tooth or alveolus, or in trauma about the jaws. The majority of these cases follow removal of mandibular molars, especially the third. As the outer wall of the mandible is much heavier than the inner wall, perforation of the lingual wall by an infectious process is much easier, allowing the infection to invade the submaxillary and sublingual spaces. The infection spreads along the muscle and fascial planes, involving the deeper structures of the neck. Such cases should be hospitalized in order that proper care and supervision can be obtained. Massive doses of sulfanilamide should be administered by a capable physician. In the majority of instances, definite results are obtained within from twenty-four to forty-eight hours, very often aborting the infection and making surgical interference unnecessary.

Osteomyelitis: Most cases of osteomyelitis of the jaw bones are a result of compound fracture. Reports have been received of good results from application of sulfanilamide powder to the site of pus discharge, but evidence is lacking as to the effectiveness of this treatment.

Necrotic (dry) socket: This condition has been designated dry socket, necrotic socket, septic socket or localized osteomyelitis. The term "alveolalgia" has been introduced by Archer to describe this painful condition. Various theories have been offered as to the etiology, but there is strong evidence that streptococcic infection is present in a majority of the cases. Archer,[6] in an analysis of 23,886 extractions, reported an incidence of alveolalgia of 0.09 per cent, or one case in every 105 extractions. Of the 226 cases studied, 79 per cent were in the mandible and 21 per cent in the maxillae. In 62 per cent, the teeth were vital, in 38 per cent non-vital. Cultures of these sockets revealed streptococci in 80 per cent of cases. Sulfanilamide applied in the socket reduced the time of ordinary treatment by 50 per cent. The treatment advocated by Archer, and which has been found to be effective, is as follows:

1. Irrigate the socket with a physiologic solution of sodium chloride (body temperature).
2. Isolate the socket with sponges.
3. Dry the socket carefully.
4. Crush a 5 grain sulfanilamide tablet and sprinkle the powder in the socket.
5. Carefully place Burlew dry foil over the socket and adjacent teeth, to retain the sulfanilamide in the socket.
6. Twenty-four hours later, remove the dry foil and repeat the treatment. Continue treatment as long as necessary.

V. CONCLUSIONS

1. Internal administration of sulfanilamide should never be attempted by the

dentist except in cooperation with, or under the direction of, a qualified physician.

2. Sulfanilamide is definitely of value in the treatment of streptococcic infections of the mouth and jaws.

3. Its greatest value to the dentist is in the treatment of infections following tooth removal or tooth or jaw disorders.

4. Sulfanilamide is of doubtful value in the treatment of gingival infections.

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USE OF THE PARALLELING SURVEYOR IN MODERN PARTIAL DENTURE CONSTRUCTION

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PERHAPS no step in the construction of a clasp-retained partial denture has more direct bearing upon the ultimate result than that of surveying the model of the dental arch for which the appliance is to be made. However, considerable contact with those interested in this phase of dental reconstructive service, from general practitioner to specialist, convinces one that no step in the entire procedure is more beclouded with uncertainty and confusion than that of using the model surveyor.

The use, over a long period of time, of various types of surveyors, from the simplest to the most complicated, has established the firm belief that the problems of partial denture design and construction can be very considerably simplified by routine employment of this instrument. The failure by many to realize the prime importance of surveying, or the lack of a clear understanding of the procedure by many who do attempt it, has been one of the major factors in delaying an advancement in partial denture prosthesis commensurate with that which has occurred in some other fields of dentistry.

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Read before the Section on Partial Denture Prosthesis at the Eighty-First Annual Session of the American Dental Association, Milwaukee, Wis., July 18, 1939.

All too common has been the discouraging experience of having to alter and reassemble the various units of an appliance because interference of certain parts with the remaining teeth or tissues was such that insertion and removal was impossible. Disheartening also, to both operator and patient, has been the frequent breakage of an appliance or the early failure of abutment teeth. Such an occurrence is often directly traceable to strain on both the appliance and the teeth during insertion and removal. These stresses are definitely preventable by effecting parallelism between units of the appliance and by coordinating these various units with tooth and tissue alinement.

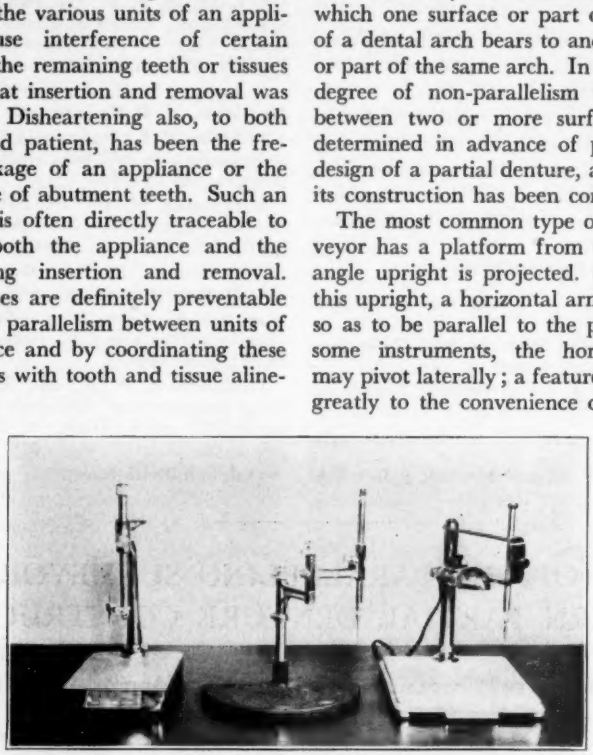


Fig. 1.—Three types of modern model surveyors.

Dentists were slow to see the possibility of applying a rather simple method of solving this difficulty in partial denture construction; for it was not until 1918 that Fortunati pointed out that "a mechanical device could be used for charting correct clasp outline."[1] He suggested the use of a bridge parallelometer for this purpose. The first instrument developed specifically for use in model surveying was designed by Weinstein and Roth and made available commercially in 1921.[2]

THE MODEL SURVEYOR

A model surveyor is essentially a paralleling device. With it, we may measure accurately the relative relationship which one surface or part of the model of a dental arch bears to another surface or part of the same arch. In this way, the degree of non-parallelism which exists between two or more surfaces can be determined in advance of planning the design of a partial denture, and not after its construction has been completed.

The most common type of model surveyor has a platform from which a 90° angle upright is projected. (Fig. 1.) To this upright, a horizontal arm is attached so as to be parallel to the platform. In some instruments, the horizontal arm may pivot laterally; a feature which adds greatly to the convenience of usage. It, in turn, supports another vertical arm, which forms a right angle with the platform. This arm, known as the paralleling rod or tool, is movable in a vertical direction to facilitate contact with the surface to be studied.

To position it definitely, the model is mounted upon a metal base which can be conveniently moved about upon the platform of the instrument. In some instruments, the model is attached to this movable base by means of a mound of wax. (Fig. 2, B.) Another has the base supported on three legs, each of which may be shortened or lengthened by means of a thumbscrew device to alter the rela-

tionship of the model to the surveying rod. (Fig. 2, C.) Still another mounting base has a table attached upon a ball and socket appliance, and this permits tipping of the model easily in all directions. (Fig. 2, A.)

POSITIONING THE MODEL

Perhaps the step in the use of a surveyor most subject to confusion is the positioning of the model. It should be visualized that a model can be tilted in two planes, laterally to either the right or the left, and anteroposteriorly either in a forward or a backward direction. Some operators have advocated an arbitrary position in which the occlusal plane of the model is made parallel to the plat-

A B C

Fig. 2.—Three different types of devices for supporting model during survey. A, model table attached to a ball and socket appliance. After it is tilted to the desired position, the model may be locked by means of the thumb screw seen at the extreme left. B, model resting in mound of wax which is attached upon movable metal base. C, model platform supported by three legs, each of which may be lengthened or shortened to tilt model into desired position.

form of the instrument. However, when all posterior teeth are missing, it is difficult to estimate accurately, at the time of the survey, the occlusal plane to be established later. Other fallacies of this method will also be noted.

By still another method, the model is related by determining the mean axial inclination of the abutment crowns in both the mesiodistal and the buccolingual plane. When there are two abutments, the average axial angle is determined in each of these directions. A line is then placed on the lateral side of the model base indicating the mean mesiodistal angulation. (Fig. 3.) The mean lateral or buccolingual inclination is shown by a line on the dorsal aspect of the model. The position of the model is then adjusted so that each of these lines is parallel to the surveying tool of the instrument. As the number of abutment teeth in a given case increases, this procedure becomes more complex, and more difficulty is encountered in estimating the mean between the axial inclinations. This method by Weinstein and Roth[3] was for many years accepted by the few who attempted the use of a surveyor as the most practical means of determining model position. In more recent years, however, the fallacies of such arbitrary systems have become more evident and other methods have been developed for making this determination.

PATH OF INSERTION AND REMOVAL

When a partial denture is placed on or removed from the abutment teeth, it must travel in a path or direction which is determined by the contact of the surfaces of the appliance with the surfaces of the teeth and, to a less degree, with the soft tissue surfaces. This path may be of a vertical direction, in line with the long axes of the crowns of the abutments. Usually, however, we find that it is not a vertical movement, but may

angle to the right, to the left, posteriorly or anteriorly. It is necessary, in designing a partial denture, to predetermine the most desirable direction of insertion and removal, and this is actually what is done when the position of the model is altered in its relation to the vertical arm of the surveyor. The fact should be kept clearly in mind that a change in model position during a survey is equivalent to changing the path of appliance movement during the act of removing from or inserting to a functional position.

SELECTIVE METHOD OF POSITIONING

In recent years, many students of the subject have discarded the arbitrary methods of relating the model to the surveyor for a way which might be called the "selective" method. By acceptance of this method, one denies the inferred premise of the Weinstein-Roth system that axial angulation of the abutments is the only factor to be considered in the choice of path of insertion. A careful study of this problem in hundreds of clinical cases has evolved the conclusion that this determination should result from a consideration of these three factors: interference, retention and esthetics.

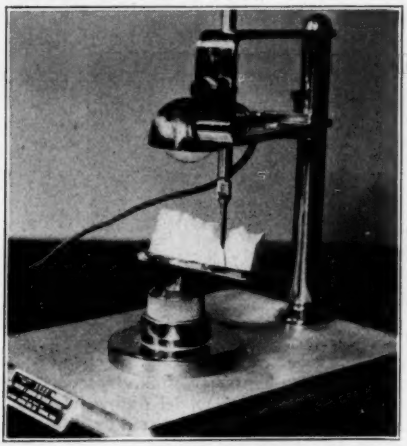


Fig. 3.—Model position adjusted so that the vertical arm of surveyor is parallel to center line appearing on model base. This line represents the mean mesiodistal angulation of the crowns of the two abutment teeth. A similar procedure is followed to determine the lateral, or buccolingual, angulation of the two abutments, with these lines appearing upon the dorsal aspect of the model base. This arbitrary method of model positioning has serious limitations.

INTERFERENCE DURING INSERTION OR REMOVAL

A partial denture, in order to be most satisfactory, must be easily inserted and removed by the wearer, with but the minimum of strain either to the appliance itself or to the abutment teeth or the tissues which support it. Interference with easy insertion and removal results from building surfaces of the appliance in contact with surfaces of the remaining teeth or ridge tissues which are nonparallel. We speak of such surfaces as being "undercut." As we know only too well, areas of undercut often occur on the soft tissue surfaces involved in a reconstructive program as well as on the surfaces of the teeth. (Fig. 4.)

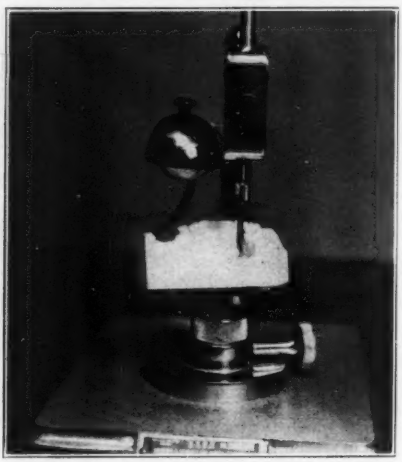
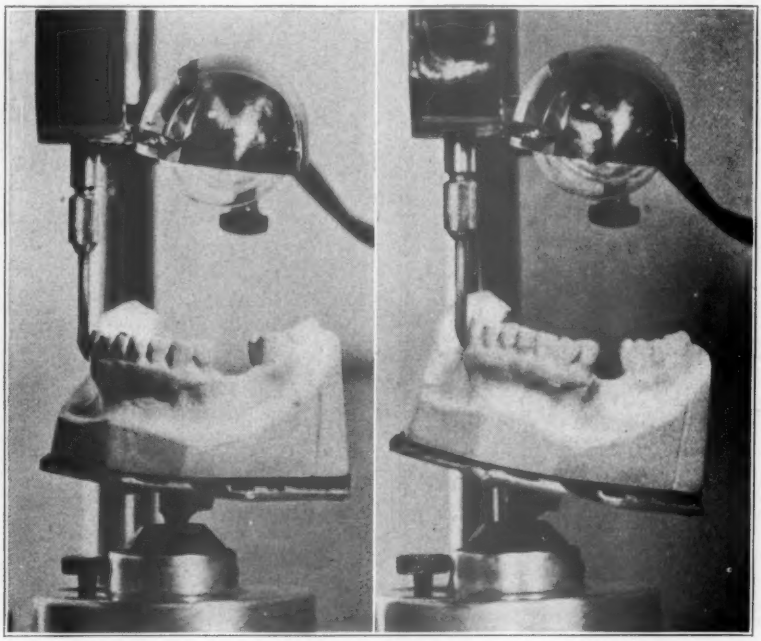


Fig. 4.—Example of tissue "undercut." Such conditions are also frequently seen lingually from the lower bicuspids and buccally from the roots of upper bicuspids or cuspids.

lacy of the axial angulation method of model relating is the failure to recognize any interference except that of tooth surface origin. Solving the problem of interference in designing a partial denture is of greatest importance and so should be given first consideration, as a rule, in choosing the path of insertion and removal of an appliance.

RETENTION

When in functional position, a removable partial denture should be retained against dislodgement from the adhesion of sticky foods, the action of muscles of the contiguous parts or, in the maxillary cases, the force of gravity. The most common error in planning a partial denture which is to be retained by means of clasps is that of creating excessive retention. The results of this are, first, that the teeth are subjected to a destructive traction from the forcing of the appliance in and out of position, and, second, that the clasps are strained with each flexure more nearly to the elastic limit of the metal, with the result that fewer flexures are required to cause fracture. To avoid these results, it is necessary to locate the terminals of the various clasps so that uniform retention is provided at each abutment of a degree that will offer only sufficient resistance to counteract the forces tending to dislodge the appliance. By altering the path of insertion, it is frequently possible to attain balanced re-



A B

Fig. 5.—A, model in position showing no "undercut" or retentive area on labial aspect of right cuspid. B, left side of model lowered (as seen in the photograph) to provide adequate retention for clasp on labial surface of right cuspid. This retentive area lies cervically from the line contact of the vertical arm of the surveyor to the curve of the labial surface of the abutment crown.

tention by decreasing the undercut area on one or more tooth surfaces and, simultaneously, increase it on other tooth surfaces.

In this connection, it should be borne in mind that undercut surfaces increase in degree of convergence on that part of the model which is lowered from the horizontal plane, and decrease on the part which is elevated above the horizontal. This rule holds true for a tilting movement either laterally or anteroposteriorly. If, for instance, the undercut area on the buccal surface of a right abutment is less than is desired (Fig. 5, B), it may be increased by tilting the model to the right. (Fig. 5, A.) This movement has the effect also of reducing the available retention on the buccal surface of the left abutment. Likewise, the retentive area on a mesial surface is increased by tilting the model forward or mesially, at the same time lessening a distal undercut. Thus, by carefully relating a model for survey, clasps may be allocated so that balanced retention is attained with an acceptable minimum of tooth and clasp strain. This desirable end-result is not accomplished to an equal degree by arbitrary methods. The haphazard method of locating each clasp independently of the others in a given appliance has been the source of many failures in partial denture prosthesis. Fortunately, this unscientific procedure is being discarded by many of those engaged in this field.

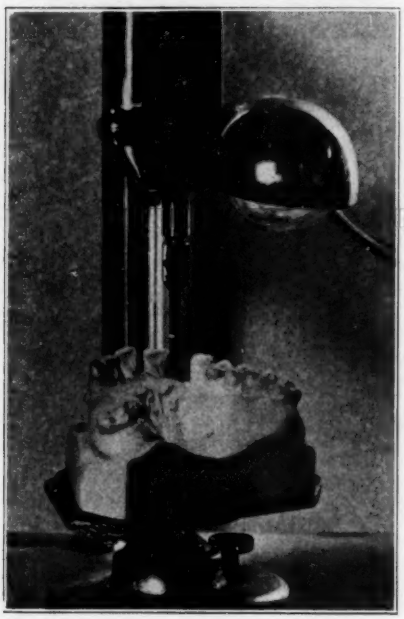


Fig. 6.—Model positioned so that lateral incisor substitute will "clear" disto-incisal angle of central incisor during insertion or removal of appliance. If a path of appliance movement was from a right or left angulation, there would be an interference created which would necessitate grinding of the porcelain substitute and would produce an unesthetic tooth form.

Fig. 7.—Surveyor used to contour wax pattern so that finished restoration will conform to chosen path of appliance insertion and removal. Unusable undercuts are thus reduced to a minimum and objectionable food pockets avoided.

ESTHETICS

The third consideration, that of esthetics, is often the determining factor in model alinement. In the replacement of one or more anterior teeth, for instance, care must be exercised in determining the path which the appliance is to travel so that it will not be necessary to grind the anterior porcelain substitutes excessively in order to "clear" the incisal angle of the adjacent anterior teeth. (Fig. 6.) This would be necessary if a lateral approach to position had been arbitrarily chosen. In the matter of esthetics also, it is possible to alter the location of clasps so that they will occupy a less conspicuous position. The most natural appearance possible should always be our goal in constructing a restorative appliance.

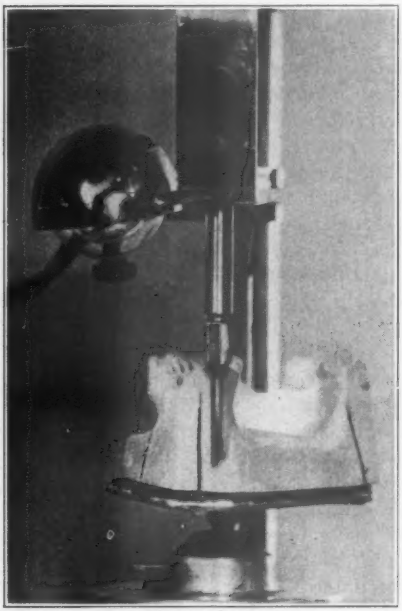


Fig. 8.—Grooves made upon lateral and dorsal surfaces of base or capital of master model parallel to vertical arm of surveyor to furnish accurate means of registering model position which has been selected. A model may be repositioned by simply being tilted until these recording lines are again parallel to the vertical tool.

In many cases, perhaps the majority, it will be found that the factors of interference, retention and esthetics are sharply conflicting. In a certain case, one would seem of greater importance than either of the others. Frequently it is necessary to effect a compromise. For instance, in the matter of esthetics just mentioned, the best possible appearance of an anterior substitute is essential, and it may be necessary to sacrifice, to a reasonable degree, the efficiency of the retainers. In another case, we may wish to attain maximum retention where the abutments are of slight convexity, and to do so it may be necessary to locate the clasps in more conspicuous areas, even though the result is not entirely harmonious with our esthetic sense.

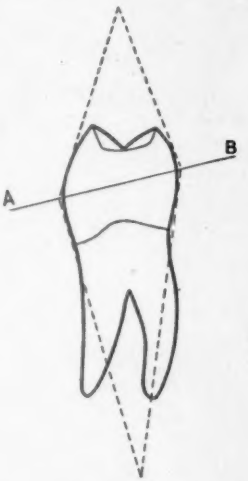


Fig. 9.—Prothero's illustration of his "cone theory" in placement of retentive clasp arm. AB represents the greatest buccolingual diameter of the abutment crown. The surfaces of the tooth converging cervically are retentive.

Keeping interference, retention and esthetics in mind, we vary the position of the model in its relation to the vertical arm until we have established the most

acceptable path of insertion for the case at hand. For greater emphasis, it may again be pointed out that the model position may be altered in two planes, laterally and anteroposteriorly, and when such change in the position of the model is made, we actually change the path of insertion. It has been noted in the study of many models that for only a small percentage of the cases has a vertical path of insertion and removal been selected. As a matter of fact, an appliance which travels vertically will be dislodged most readily by the pull of sticky foods. Hence, the fallacy of arbitrary positioning, in which the occlusal plane is made parallel to the instrument platform, becomes apparent. Alining the model for survey is made much easier if the operator will keep in mind, first, that the finished appliance must be easily inserted and removed; second, that it must be retained against reasonable forces which tend to dislodge it, and, third, that it must be characterized by the best possible appearance. The selective method of positioning has been found to accomplish these desired results more effectively than the arbitrary methods of the past.

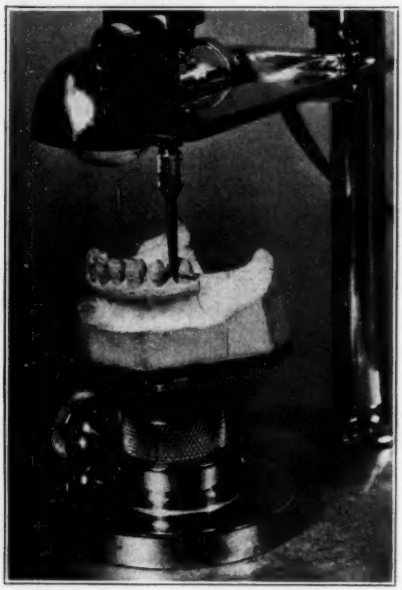


Fig. 10.—Height of contour delineated upon abutment tooth surface by carbonizing straight edge of vertical tool of surveyor and drawing it across tooth surface. Care should be taken that the point of the tool does not mark. The correct relationship is that of a tangent to a curve. Cervically from this height of contour, the tooth surface is retentive. Occlusally, it is non-retentive.

SURVEY OF THE STUDY MODEL

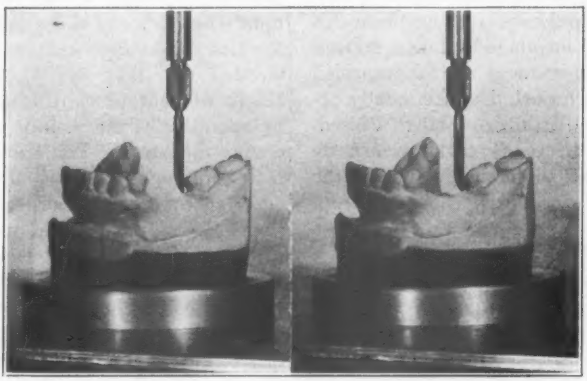
One of the most important uses to which a surveyor may be put is the preliminary survey of a study model. In almost all mouths requiring partial dentures, there will be found caries or defective restorations of the abutment teeth. In restoring these teeth for use as supports, it is quite easy to eliminate some of the non-parallelism, particularly of the proximal surfaces adjacent to the edentulous areas. It seems illogical to contour these surfaces so that unusable undercuts will be present. A preliminary survey of an accurate study model will give a definite conception of how to design these new restorations so that the surfaces will be in harmonious alinement with those of the appliance to be constructed. If the abutments require full crowns, it is just as easy to contour them so that subsequent interference to appliance insertion is reduced to the minimum and, likewise, so that it will be possible to procure retentive areas at the desired locations. This is easily accomplished by the use of a surveyor. The construction of a full crown without regard to these matters leads to needless difficulties when designing of the appliance is attempted.

Occasionally, the preliminary survey discloses abutment teeth which do not offer even the slightest possibility of clasp retention. If this condition is known in advance, it may be corrected either by inserting an inlay which provides an increase in the degree of convexity of the

tooth or by the creation of a slight depression at some point on the crown surface which will make effective clasping possible. How much better it is to know this condition in advance and to provide a solution rather than to construct the case and then find retention inadequate!

One other important advantage of a careful preliminary study is that we may know in advance of taking the final impression exactly which areas are essential and which are non-essential so far as the design is concerned. Knowing this, we may accept an impression which may not be perfect in every detail, provided such defects occur in areas that are not to be used. This frequently obviates taking another impression.

Much of the success of a partial denture results from proper preparation of the mouth prior to the final impression. In a small percentage of cases, it may even be necessary to resort to surgical treatment of the soft tissues in order to facilitate the reconstructive program. This is particularly true where anatomic anomalies exist, such as pendulous soft tissue irregularities, severe tissue undercuts or *torus mandibularis*. Interference from such sources may not be readily detected without the aid of the surveyor and so is not discovered until the appliance is finished and first tried in the mouth.



A B

Fig. 11.—A, undercut area. B, area eliminated. After the most desirable path of appliance removal and insertion has been chosen and the position of the model recorded, the unusable undercut areas may be blocked out by adding a suitable material and carving it parallel to the vertical cutting tool.

RECORDING THE MODEL POSITION

When the tentative path of insertion and removal has been determined on the study model, a record should be made of this so that the final master model upon which the case is to be constructed can be placed in the same position. One way of recording this relation is to cut shallow grooves on the sides of the model parallel to the vertical tool. A groove is preferable to a penciled line since it is less likely to be accidentally removed, and also because it will be transferred to a duplicate model. Of these grooves one should be on the dorsal aspect of the model base and one on each lateral side. As an aid in accurately realining a model, the recording grooves are as widely separated as possible. At any time, then, a model marked in this way may be repositioned very quickly by again bringing these lines parallel to the vertical arm.

Much time can be saved in making the final design if the survey is started with the master model in the approximate

position occupied by the study model. We may wish to alter this because of changes made in the teeth or in the contour of the edentulous ridges since the study impression was taken, but at least that position should be used as a starting point. These recording grooves should again be made on the master model (Fig. 8) as a means of registering permanently the model position for reference during the process of appliance construction or for possible later repairs. Also, when the master model is duplicated, the grooves will reappear on the base of the casting model. Then if, during the making of the wax pattern, a recheck of some area on the instrument seems necessary, it is possible quickly and accurately to place this casting model in precisely the same position on the instrument as that occupied by the master model. This frequently occurs if cast clasps are being utilized, because it is necessary to know exactly the degree of undercut in which the terminus of the cast clasp is being placed.

THE "HEIGHT OF CONTOUR"

It is hardly logical to conclude a consideration of surveying without mentioning at least briefly the matter of clasp location, because one of the most important uses to which the surveyor can be put is a precise determination of the correct placement of the clasp arms. Perhaps the best approach to an understanding of this problem can be made by recalling the work of Prothero. It was he who advanced many years ago the so-called "cone theory" in clasp design. He suggested that the surfaces of molar and bicuspid teeth conform to two cones.[4] (Fig. 9.)

One cone may be superimposed on those surfaces of the crown which converge toward the occlusal portion. Another cone will conform to the surfaces of the crown converging toward the cervical portion. The occlusal and cervical cones so superimposed on the crown surfaces are found to meet in an irregular line around the tooth at its greatest diameter. This line on the tooth where the two cones coincide was later designated by Cummer[5] as the "guide line," since it served for him as a guide to the location of the clasp arms. Kennedy, still later, called it the "height of contour,"[6] a term which is generally accepted today. Devan[7] has aptly referred to cervically converging surfaces as "infrabulge" areas and the occlusally sloping surfaces as "suprabulge" planes.

A terminus of a clasp located cervically to the "height of contour" on an infrabulge slope is retentive because the clasps must open in order to pass over the crest of the bulge at the height of contour. The nature of clasp metal is such as to resist this change in form. It has been pointed out that the location of the height of contour can be made to vary by alteration of the position of the model during the survey. This has the effect of increasing or decreasing the degree of cervical convergence of the infrabulge slope. Thus, the retentivity of a clasp may be accentuated or lessened as the need arises by the simple means of altering the position of the height of contour.

After we have established the position of the model, we may scribe upon each abutment tooth a mark indicating the height of contour merely by drawing the paralleling tool across its surface. (Fig. 10.) To facilitate this procedure, the rod should first be rubbed with carbon. Care must be exercised in scribing this line to prevent the end of the rod from making the mark. Instead, the contact of the tool with the crown surface should be a straight line tangent to a curve.

LOCATION OF THE RETENTIVE CLASP

The distance from the height of contour that a retentive arm is to be placed will vary and the position ultimately chosen will depend on several factors. The first is the angle of cervical convergence of the infrabulge surface. It converges either steeply or gradually. The

less the convergence, the greater the distance the clasp should be located cervically from the height of contour because the amount which it will be required to open in order to pass over the surface bulge is less where the convexity is of less degree. The structure of clasp also must be considered because a wrought clasp, being more flexible than a cast one, can be placed more deeply in the undercut region. The form of the clasp arm (round or half round), its length, the gage or diameter of the arm and whether it lies in one plane, the horizontal, or in both vertical and horizontal planes are other factors in flexibility and hence influence clasp location.

With a knowledge of these facts and the aid of a surveying instrument, we can accurately predetermine the degree of retention which is to be provided by each retainer, so that sufficient stabilization will result without the danger of excessive retention. The importance of avoiding the latter condition cannot be overemphasized. Straining either the clasp or the abutment tooth during insertion and removal is the cause of much abutment tooth injury and frequent clasp failure.

ELIMINATION OF UNDERCUTS

Not all abutment tooth strain arises from improper clasping. Such stress is also the result of wedging when an appliance has been constructed in areas of undercut. It should be apparent that the use of an infrabulge area too severe in degree will result in interference with insertion and removal. Not only does this pertain to the units of the appliance which contact the abutments directly: it also applies to the tooth or tissue surfaces of the entire structure. There must be no exception to the fixed rule that the surfaces of all rigid parts of the removable partial denture which are to contact tooth or tissue surfaces must be parallel to the chosen path of insertion and removal.

To accomplish this requires an optical acuteness which but few possess. The model surveyor offers definite and valuable aid in measuring the degrees of undercut so as to avoid points of interference, thus reducing to a minimum the adjustment required after construction has been completed. Here, indeed, is the place to practice the "ounce of prevention" idea.

Before the casting model is made, areas of unusable undercuts (Fig. 11, A) should be blocked out on the master model at least parallel to the path of insertion and removal. This may be accomplished by placing clay or wax in such areas. (Fig. 11, B.) Some surveyors are equipped with a cutting blade on the paralleling tool, with which the blocking material can be quickly shaped. The resulting casting will then be free of interference with the tooth surfaces. This not only saves material, but also reduces to a minimum the amount of correction that must be made in the finished casting. If this were the only use made of the surveyor, it would more than justify its routine employment. All in all, the intelligent use of the model surveyor has done as much to perfect the partial denture as any other single development of the twentieth century.

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2015 Woodside Road.

A CLINICAL PICTURE OF OSTEOMYELITIS OF THE JAWS

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OSTEOMYELITIS of the jaws is a relatively common ailment, which, if not promptly recognized and properly treated, becomes a mutilating process, owing to the destruction of bone and soft tissue, often resulting in deformity of the face and not infrequently in death from general septicemia.

The correct treatment of osteomyelitis of the jaws, like the correct treatment of any disease, depends on a correct diagnosis. A wrong diagnosis and mistaken therapeutic measures are more likely to disseminate disease than to cure it.

DIAGNOSIS

It is easy to diagnose long standing chronic cases of osteomyelitis even without the x-rays. On the other hand, it is sometimes difficult to recognize acute osteomyelitis in its early stages even with the x-rays. However, one should never fail to make a thorough roentgenographic examination of the teeth and jaws and to get as complete a history of the case as possible. If we encourage the patient to talk about his case, we may obtain some valuable information, keeping in mind that the chief cause of all types of periostitis and osteomyelitis of the jaws is dental infection, root abscess, pyorrhea, Vincent's infection and a general unhygienic condition of the mouth.

The next, but lesser etiologic factor is trauma. Injuries that cause fracture of the jaws and teeth, or blows upon the face that do not fracture, but cause infiltrating swelling around the bones, frequently lead to osteomyelitis. The clinical picture becomes more suggestive when, added to all the conditions that I have just mentioned, there are swelling, pain, tenderness and a rise in temperature and in the leukocyte count, with areas that fluctuate and are painful on pressure, indicating a well-advanced inflammatory process and a probable osteomyelitis.

TREATMENT

"Science relies upon experience rather than authority." (Julian Huxley.)

Conservatism and patience are indispensable in the treatment of osteomyelitis. Abscesses must be opened and adequate drainage must be maintained, with occasional irrigation with a warm 2 per cent chloramine-T or boric acid solution during the process of sequestration and formation of an involucrum.

The use of sulfanilamide is distinctly advantageous and should be instituted early in adequate therapeutic doses, to be continued until improvement in the clinical picture is noted.

The parts should be immobilized and the patient be kept quiet and free from pain. Physiologic rest is always best assured with the patient in a comfortable bed and in a warm room, and the administration of morphine and the barbiturates in sufficient doses whenever necessary. The diet should be soft, with plenty of fluids and fruit juices.

In severe infections, hot wet dressings should be used freely and continuously. Magnesium sulfate should not be used for catharsis in the presence of sulfanilamide, the use of fluid extract of cascara sagrada or normal saline enemas when necessary being preferable.

Roentgenograms should be taken at intervals to check up on the changes taking place in the osteomyelitic process.

The following cases, which are typical, illustrate how an incorrect diagnosis followed by the wrong therapeutic measures disseminates disease instead of curing it.

REPORT OF CASES

CASE 1.—Mr. G. aged 52, who was suffering from chronic osteomyelitis of lower jaw, with a temperature of 99, was referred for treatment after fourteen months of sporadic medical and surgical care. The trouble began after the extraction of the lower left second molar. The patient's face was greatly swollen and saliva dribbled from the corner of the mouth. Inside the mouth, the mucous membrane on the left side, extending from the alveolar ridge onto the buccal surface of the cheek, was a necrotic, sloughing mass.

A large sinuous fistula originating in the alveolar process of the lower jaw extended upward, ending in an open sore three-fourths inch in diameter on the outside of the cheek just below the zygoma.

The tissues everywhere were discolored and edematous, with a very offensive odor. Numerous incisions had been made in the mouth, face and neck and, according to the patient's story, he had been told that he had cancer, syphilis and tuberculosis, none of which he had. However, he was diabetic, with a blood sugar content of more than 200 mg. (Fig. 1, left.)

Cleansing the mouth, establishing adequate drainage, irrigating with a mild chloramine-T solution and the removal of sequestra at intervals as sequestration proceeded afforded a cure.

Two months later, when there was no longer any pus and the danger of recurrence of infection had passed, I performed a plastic operation on the face for the removal of several deep scars, one an especially deep, dimpling scar at the site of a large sinus below the zygoma. The very gratifying result is shown in Figure 1, right.

Fig. 1 (Case 1).—Left: Appearance of patient at time of examination. Right: Results of treatment and plastic operation.

CASE 2.—Mr. S., a farmer, aged 32, had an acute osteomyelitis, with a temperature of 102 and considerable cellulitis and swelling extending down the neck to the submaxillary gland region below the angle of the jaw on the left side, this area being fluctuant and painful to pressure. The trouble originated in a badly decayed pulpless second molar and a periodontal abscess surrounding a partially impacted third molar.

The inflammatory process had been present for about four weeks, during which the patient had received palliative treatment from his family physician and his dentist. He came to me because of a sudden rise in

temperature, increased swelling, pain and trismus. (Fig. 2, left.) Treatment consisted in the immediate opening of the abscesses on the neck and evacuation of a large amount of pus, extraction of the offending teeth and maintenance of adequate drainage with rubber dam drains as shown in Figure 2, center, or eight months, remained. (Fig. 2, right.)

It might be more nearly correct to consider this case as one of periostitis instead of osteomyelitis, because the inflammatory process had not proceeded to the stage of necrosis and sequestration of

Fig. 2 (Case 2).—Left: Appearance of patient at time of operation. Center: Rubber dam drains in place for drainage. Right: Results of operation.

Fig. 3 (Case 3).—Left: Appearance of patient when first seen. Center: Appearance forty-eight hours after operation. Right: Results twelve weeks after operation.

supplemented by the necessary supportive care as outlined under Case 2.

Recovery was rapid, and ten days after the operation, only two small scars, which will probably disappear in the course of six

bone. Nevertheless, it is well to remember that the line between periostitis and osteomyelitis is quite narrow.

CASE 3.—E, a girl, aged 9, presented what

proved to be an acute fulminating osteomyelitis of the mandible on the left side, originating in a decayed pulpless lower first permanent molar.

There was no well-defined rarefied area about the root apices to indicate a definite abscess, but the bacteria-laden exudate from the infected tooth had burrowed its way down along the roots and between the periosteum and the bone to the lower border of the mandible, where a virulent and active inflammatory process, followed by suppuration and necrosis, set in, continuing until after the removal of numerous small sequestra through the incision at the lower border of the mandible.

When first seen, the patient had a temperature of 101.4°. There was a large swollen, fluctuating and tender area below the border of the mandible, indicating an abscess. (Fig. 3, left.)

The mouth was irrigated with a warm solution of sodium perborate and the face scrubbed with green soap and water, then painted with mercurochrome. The abscess was opened and the tooth removed under gas-oxygen anesthesia, and a rubber dam drain inserted. Figure 3, center shows the patient forty-eight hours later, much improved with swelling reduced and a temperature of 99.2°.

This was a stubborn infection and the patient was not pronounced cured until twelve weeks later. Figure 3, right shows the patient at that time, the scar being practically invisible. External incisions should be made whenever possible below the border of the mandible or in the natural folds of the skin.

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PHYSICAL FACTORS IN THE PRODUCTION AND CONTROL OF DENTAL PAIN

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THE physical factors in the production and control of dental pain will be dealt with in two phases: (1) a consideration of the theories regarding the mechanism of processes present in the dentin when pain is felt, and (2) a consideration of those factors more or less under the control of the operator, by which pain may be increased or decreased.

Treatment of the first phase of the discussion must be mostly negative because of a lack of information verifiable by scientific methods. I believe, however, that treatment is justified by the importance of the subject and by the hope that the shock to our complacence produced when doubt is cast on the authenticity of some of our ideas may keep alive the interest and enthusiasm which are so necessary to progress.

The anatomist has traced the paths by which painful sensations are conveyed from the tooth to the brain. The histologist has shown us the minute structure of the tissues where the sensations of pain arise, and also those by which it is transmitted. The physiologist has discussed both qualitatively and quantitatively the mechanism by which impulses travel along the nerves.

These contributions seem to be analogous to an explanation of the functioning of a modern radio receiver based on the laws of electrical circuits, but

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without a consideration of the mechanism by which the radio tube detects and amplifies.

What happens in the dentin of the tooth is the important missing link, without a knowledge of which we shall never thoroughly understand dental pain.

The histologist has tried to solve the problem by searching for nerve fibers in the dentin. Some assert that they have seen these fibers; others, denying this, have proposed theories based on the tubular structure of the dentin and the nature of the tubular contents. I may be permitted to mention some of these theories because they all postulate physical phenomena having to do with the expenditure of energy.

G. V. Black[1] ascribed sensation to contraction of the odontoblast and its fibril, similar to muscle contraction. The odontoblasts, being in contact with the nerve ends stimulated the latter, sensation resulting. Gysi assumed that a wavelike motion along the protoplasm caused excitation of the sensory nerves, this being possible because of the incompressibility of the fluid contents of the dentin and the pulp chamber. Hopewell-Smith assumed that the odontoblast, a mesodermal cell, either functioned as an end-organ, an ectodermal cell or a highly organized mesodermal cell, muscle.

Later, Hopewell-Smith subscribed to Tomes' explanation; *i.e.*, that "pain is the consequence of pressure on the inelastic columns of intratubular material and the softened (decalcified) intertubular matrix of the dentine transmitted . . . to the surface of the pulp." He, however, took no notice of Tomes' conclusion that "this assumption does not, however, account for all the circumstances of the case, failing altogether to explain the greater sensibility of the dentine in one part of the tooth than in another." Hopewell-Smith, therefore, subscribed to a theory discarded by Tomes seventy years previously.

More recently, Prinz[2] advanced a theory in regard to so-called hypersensitive dentin which cannot be overlooked in any discussion of dental pain. He points out that the non-innervation school is divided into two groups: (1) those who believe that sensation is due to abnormal movements of molecules in the dentinal fibrils and (2) those who believe that it is due to "demarcation currents, convection and osmosis." Prinz alined himself with the latter group.

It is maintained that in the condition referred to as hypersensitive dentin, the contents of the dentinal tubules have been pathologically altered by "external physicochemical influences." Gibbs' equation for the relation between surface concentration and surface tension in colloidal solutions is invoked and pain is ascribed to an increase in hydrostatic pressure (the concept is somewhat involved here), resulting from an increase in surface tension acting in the fine capillaries of the dentin and an increase in osmotic pressure resulting from the dialysis of water solutions of foreign substances through a membrane formed by the concentration of colloids in the surface film.

This theory is certainly a step in the right direction and a great improvement on preceding ones. However, there seem to be too many facts which do not fit into the picture to permit its acceptance without considerable modification.

While added solutes may concentrate in the surface and reduce surface tension by more than half,[3] few common substances have yet been discovered which will raise surface tension more than a few per cent. Furthermore, solutes which raise surface tension are retained in the bulk of the solution and so do not concentrate in the surface film. It follows that substances which might form membranes through which an osmotic pressure could be built up by dialysis reduce that pressure by a decrease in surface tension; while those substances which can cause a slight increase in surface tension

form no film through which to set up an osmotic pressure. The net result would depend on the relative magnitude and direction of the changes in the component pressures.

Aside from the foregoing consideration, there are other factors in an evaluation of this theory. Let us assume that an increase in hydrostatic pressure could be brought about by the foregoing means, and that this pressure applied to the nerves in the pulp tissue caused pain. Except in cases of an extreme passive hyperemia, we could expect this increased pressure in the pulp chamber to be comparatively rapidly equalized with that of the rest of the tissue fluids through the foramina of the tooth root. This would then account for a transitory state of disturbed equilibrium upon exposure of the dentin to the oral fluids, but it would not account for the pain experienced when, for example, the dentin is touched with the small point of a sharp explorer, as there is no change in the quantity or chemical nature of the solutions. Besides, clinical experience indicates that there is no pain when the saliva comes in contact with exposed dentin.

The building up of pressure in the tubules and pulp chamber would require an actual movement of the contents of the dentinal tubules. The velocity of ions and charged colloidal particles, even when urged along by an electric pressure of 1 volt, is of the order of one-hundred thousandth of an inch per second. Thus, any increase in pressure produced in accordance with this theory would require a period of time out of all proportion to that observed in clinical practice.

Further, when the small volume of the tubules whose ends are in contact with a sharp pointed instrument is compared with the volume of the pulp chamber (and that with one or more foramina the cross-section areas of which may greatly exceed that of the instrument), it does not seem possible to build up any pressure in the pulp chamber from without.

Finally, it is common clinical knowledge that the most sensitive part of the crown is at the amelodentinal junction, yet there are, because of their radial arrangement, few tubules per square millimeter at this point as compared to those close to the pulp. If pressure explained the presence of pain, we should expect the pain to increase as the pulp is approached.

The question may now be asked: What theory can then be substituted for the "surface tension osmotic pressure theory"?

A theory is a plan or scheme based on accepted principles and verifiable facts. There are almost no such principles or facts at present—not enough probably to form a working hypothesis. In view, however, of recent developments in surface chemistry and chemical physics, and in spite of my superficial acquaintance with these developments, I shall attempt to indicate the direction in which the next forward step will, I believe, be taken.

In the simplest description, molecules may be considered as groups of atoms held together by electrostatic attraction. They are neutral as a whole because their positive and negative charges are equal. However, these charges are a finite distance apart and may be unsymmetrically grouped so that one part of the molecule has a positive charge and another a negative charge. Such a molecule, when brought near a positive electrode, will orient itself with its negatively charged part toward the electrode, in the same manner that the north pole of a magnetic compass swings toward the magnetic north pole, which actually corresponds to the south pole of the compass. Such unsymmetrical molecules are called polar molecules. The electrically symmetrical are called non-polar.

Many of the complicated organic compounds are composed of groups or radi-

cals such as the azo, carboxyl and ketone groups, some of which are polar, others non-polar. The molecule may therefore be very unsymmetrical electrically, and the larger ones may have a length several times their width and thickness.

Langmuir, who since 1920 has been investigating the properties of very thin films of some of the simpler compounds, was able to study films of but 1 molecule in thickness. He also showed that these molecules were packed side by side like a bundle of sticks and stood on end. By depositing these films on different solid and liquid surfaces, he was able to show that sometimes one end of the molecules would be in contact with the surface and again the other end. In other words, the orientation of the molecules was determined by the nature of the molecules with which they were in contact, and when the latter changed their electrical nature, the molecules of the film reversed ends or turned over.

Because of the unsymmetrical electric nature of these molecules, the free surface of the film changed its physical, electric and chemical properties. This was shown by the difference in behavior, for instance, of drops of oil or water when placed on the films.

Langmuir[4] suggests that the phenomena accompanying the overturning of these films "may perhaps explain the mechanism which propagates nerve impulses."

The plasmalema of the odontoblast is a film. The idea suggests itself that it may some day be shown that, under certain circumstances, this film can be made to produce electric impulses due to sudden changes in its electric potential. Such a concept would overcome some of the major objections to the "pressure theory"; namely, the actual displacement of the contents of the tubule with its resulting slow action, the ratio of the volume of the pulp chamber to the volume of the involved tubules and, lastly, the equalization of pressure in the pulp chamber by release through the apical foramina.

A consideration of the possible mechanisms by which painful sensations may be produced in the dentin is of great interest to the dentist, and an understanding of the problem may revolutionize present-day methods of pain alleviation. However, in the absence of knowledge of this phenomenon, we are obliged to rely on accumulated clinical data.

It is recognized that not all teeth are painful when operated upon, and it is no doubt true, as is frequently said, that the production of pain is not a function of normal dentin.

I believe that any one who has observed the patients in our operative clinic will agree that the patient who gives evidence of suffering is decidedly the exception, though not so rare as we might wish.

Aside from various systemic conditions, such as convalescence from influenza, the common cold and menstruation, there are certain physical factors to be considered in the case of so-called hypersensitive dentin.

Large cavities with soft decay, and particularly those on the labial and buccal surfaces of the teeth, are prone to be very sensitive. In interproximal cavities, we may operate painlessly if we begin by sinking a pit below the dentino-enamel junction to form the step on the occlusal surface until the carious portion of the tooth is reached. It is a common experience to have a tooth become more painful as the cavity preparation proceeds in spite of the fact that the dentino-enamel junction, reputedly the most sensitive portion, has been passed; or to have a tooth that was prepared without pain at one sitting, and supposedly sealed, be very painful when the patient returned a few days later for completion of the operation.

These experiences have led us to the conclusion that contact with the oral fluids is responsible for this condition. We are not necessarily responsible for those teeth that are sensitive when the patient

first presents himself, but we should be able to prevent this condition in the majority of the latter cases.

The use of the rubber dam is one of the best methods of preventing unnecessary pain in a large number of cases. This is probably the main reason for the comparatively small number of difficult cases in our clinic.

The chief source of the sensitivity developing between visits seems to be the "temporary stopping" used to protect the exposed dentin. Cavities sealed with baseplate gutta-percha, temporary cement or zinc phosphate cement are much less likely to be painful when the patient returns. A material used for this purpose which is subjected to the force of mastication must be rigid enough to withstand a moderate force and, at the same time, be elastic enough to resume its original form after the force is removed. The so-called flow of the plastic temporary stopping is as undesirable here as it is in silver amalgam.

The question may now be asked, "If the exposure of the dentin to saliva causes this sensitivity, will protecting or drying the dentin prevent it?"

The use of drugs for pain control does not constitute a part of my discussion, but it is common knowledge that no agent used for drying the dentin seems to penetrate deeply enough to compensate the operator for the time consumed in its application.

Sealing of the tooth is recommended by Bodecker and Applebaum,[5] who report a "great reduction of sensitiveness of the partially decayed dentine" after excavating the leathery decay and using as a filling zinc phosphate cement, left in for a month. My own clinical experience has been somewhat similar though scarcely of such nature as to permit a definite statement.

This is similar to what takes place in a permanent restoration, except in the point of time. However, in this case, secondary dentin is formed, blocking off the tubules. Whether a period of several weeks or a month would be sufficient for this, or the beneficial effects are due to a return to the normal state of the contents of the tubules, I am unable to say.

Other conditions being the same, the selection of instruments and the manner of their use are most important factors in the reduction of pain, and, fortunately, within easy control of the operator.

Instruments listed by Bodecker[6] in the order of their ability to decrease pain are: burs, excavators, stones and chisels. This order follows closely the heat-producing capacities of these instruments, as shown by Jeserich.[7] However, so many accompanying conditions enter into the problem that one should not accept this evaluation without qualifications.

Jeserich carried out experiments in which he used a small thermocouple cemented into a small hole drilled into the pulp chamber on the buccal surface near the cervical line of freshly extracted teeth. In a second series of experiments, he circulated thermostatically controlled water through the pulp chamber by way of the root canals. Finally, he inserted the thermocouple in the pulp chamber of teeth that were to be extracted, after blocking them off with a local anesthetic. He prepared the cavities within fifteen minutes, using burs, disks and stones.

The results were similar in all three cases, showing a rise of from 1 to 25 or 30 degrees F., depending on many factors in the operative procedure. On a given tooth, the thermal changes were found to depend on the "(1) size, sharpness, and speed of rotation of the revolving instruments used; (2) pressure exerted; (3) direction of pressure, whether pressure is exerted in one or more directions at the same time; (4) whether pressure exerted is a sustained pressure or an intermittent one; (5) whether the operation is performed in a dry, moist, or wet field."

Other factors being equal, small in-

struments produced less heat than large ones. With the small round and inverted cone burs, the heat was "small even with considerable abuse of other factors." With stones, the heat was proportional to the size of the stone. The direction of pressure was especially important with fissure burs and cylindrical stones. In making an occlusal cut with downward pressure for depth as well as a lateral for extension, much heat resulted. Downward pressure alone with these instruments produced a great deal of heat.

With any instrument, a dry field produced more heat than a wet one, but, in the dry field, the bur was better than the stone. The burs became clogged in the wet field and required frequent cleaning. An intermittent pressure of three to four seconds applied at different points each time and with the engine running in second speed, about 1,500 to 2,000 r.p.m., seemed to give the best results.

Because Jeserich's findings in regard to heat production run so nearly parallel to clinical findings in regard to pain production, we are justified in assuming that heat is an important factor in this phenomenon. However, heat alone is far from explaining all pain in operative procedure.

While stones used in a wet field may produce less heat than burs in a dry one, a dry field is preferable for other reasons. This is notably true with reference to determining the extent of decalcification of the enamel and dentin, which may be masked by the water. Further, the use of stones for finishing enamel walls and margins is uncalled for, Gillett and Irving[8] having shown that a sharp chisel properly used produces as smooth a margin as a stone, while on plane surfaces the chisel is superior.

From the standpoint of pain as well as the life of the cutting instrument, the use of fissure burs and cylindrical stones is usually contraindicated in extending a cavity. In working on all but proximal surfaces, these instruments must cut enamel to the same extent that they cut dentin. The enamel, being a much harder substance, requires a longer time for removal or a greater pressure for the same time, resulting in greater heat, not to mention greater destruction of the instrument.

Once an opening to a depth just beyond the dentino-enamel junction has been made, the inverted-cone bur may be used to undermine the enamel, which may then be removed by drawing the bur toward the surface of the tooth or by cleaving the enamel with a chisel. The base of the bur is held parallel to the outer surface of the enamel and, with a lateral pressure, the edge formed by the base and side of the bur is sunk into the dentin. The actual amount of tooth structure removed in this way is small, with a correspondingly slight degree of heat.

Before proceeding with the next factor in pain production, it is necessary to call attention to some facts regarding the histology of the dentin. 1. The dentinal tubules are arranged radially from the pulp chamber and consequently are approximately at right angles to the enamel surface. 2. Under the enamel is a narrow region in the dentin, with spaces, known as the interglobular spaces of Czermak, which are relatively poorer in inorganic and richer in organic material.

In consideration of the foregoing, it is readily seen that if the cut is started slightly below the sensitive region of the interglobular spaces and the shank of the bur is held at right angles to the involved tooth surface, the edge of the inverted cone, advancing under a lateral pressure, will sever the dentinal tubules before the top of the sloping sides of the cone engages the corresponding interglobular space. This should prevent transmission of impulses arising in this space; but while this procedure tends to lessen pain, it is often not completely successful. It may be assumed that this is due to anastomosis between the contents of neighbor-

ing spaces, permitting transmission of impulses to tubules in advance of the bur. This assumption is in line with a statement by Bodecker,[6] who points out that well-calcified teeth are less sensitive than those that are poorly calcified.

Because of inaccessibility, it is not possible, in most cases, to hold the shank of the bur perpendicularly to the tooth surface in operating on proximal surfaces, particularly in posterior teeth. Here, the inverted cone loses some of its advantages over the fissure bur as the cutting must be done in each case with the side of the bur. The only advantage of the former would seem to be that it engages less dentin at one time because of its shorter cutting surface.

The manner in which the bur is applied to the dentin is a factor in the degree of pain resulting. Nylander[9] points out that the engine should be run at low speed before the bur touches the tooth; and, after it makes contact with the dentin, the speed and pressure should be steadily increased.

As stated before, on the authority of Bodecker, the chisel, of all instruments used for cutting dentin, causes the least pain. This is generally conceded. The reason is not clear, but if one were to speculate regarding it, he might assume that the condition is partly subjective, as is all pain in the last analysis, and that it is due in part to lack of vibration and noise and to a reduced heat production. Regardless of other considerations, the fact that the patient believes the use of the chisel less painful is sufficient reason for its employment wherever possible.

Pain due to the use of the excavator, which Bodecker rates next to the bur in pain-producing potentiality, may be lessened by selecting an instrument with a blade just large enough to scoop out the major part of the leathery decay in one piece, and then inserting its edge under the margin of the decay and passing it along parallel to the still calcified dentin with as little pressure toward the pulp as possible.

No consideration of pain in operative dentistry would be complete without a reference to sharpness of instruments. The difference in the patient's reaction to sharp and to dull instruments is marked, as has been demonstrated in our clinic on numerous occasions.

There is little room for doubt that there is a difference in operators' technic as regards the degree of pain produced, aside from the selection and condition of the instruments. The handling of the instrument in respect to the degree of pressure, the speed and the amount of tooth structure engaged by the instrument are important factors.

In consideration of the subjective character of pain, it is logical to assume that the operator's manual dexterity and self-confidence are of consequence. On several occasions, I have known patients, squirming under the hand of a student, to permit an instructor to work on the same area and with the same instruments, and to declare that the operation caused them no discomfort. Whether the condition is truly pain or fear matters little since the result was as satisfactory to patient and operator in the one case as it was unsatisfactory in the other.

Experience indicates that the best physical means of combating pain in operative procedure is a dry tooth, preferably under the rubber dam, with small sharp inverted-cone burs working below the dentino-enamel junction for extension into sound dentin, sharp hand instruments wherever possible, care and a high degree of skill.

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POSITIVE MECHANICAL BRIDGE FIXATION

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CONSERVATIVE mesioclusodistal and even proximoclusal inlays can be made more retentive for fixed bridge attachments than the more destructive and more difficult types of cast retainers in use today. In fact, by an easy method, these simple attachments can be made so retentive that they cannot be released from their cavities until part of the gold that retains them is removed.

The development of modern fixed bridgework can be divided into three periods. The first period, of a generation ago, attained its zenith with the development of the gold shell crown and the Richmond crown, with its post in the root canal.

Despite their great security, these attachments were discarded because of their biologic disadvantages: the ever-present gingival irritation and the necessity of pulp devitalization for the post crowns.

The second period was ushered in by the casting process. This period, as represented by the three-quarters crown and various other more or less destructive and difficult attachments, is at its height today. The advances of this period over the first one are almost entirely biologic. True, gingival irritation has been reduced and devitalization of pulps eliminated, but there has been no advance mechanically in the direction of increased security of fixation. In fact, the fixed bridgework of today is less secure than that supported by the destructive crowns of the first period.

The more conservative attachments of today, like the stronger attachments of the first period, still depend primarily on cement for fixation, and, in too many instances, the smaller attachments of today have loosened, with disastrous results. From the standpoint of retention, the bridgework of today is inferior to that of thirty years ago.

The possibility that we are at the threshold of the third period in the development of bridgework now looms.

By employing a simple fundamental mechanical principle for bridge fixation, we can even exceed the advantages of today's less destructive attachments and actually equal or improve on the security of the mutilating bridgework of the first period. In fact, by employing this principle for bridge fixation, even the least destructive type of inlay attachment, such as a proximoclusal, at present recognized as rarely retentively adequate, takes on a new usefulness.

It is no longer necessary to depend on cement for fixation of bridges. Bridgework can be locked to place so securely that it cannot be removed even though

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the cast attachments are uncemented. The prime purpose of cement is now the prevention of caries under the attachments. And this increased retention can be attained in less time and with less tooth destruction than is required to construct the type of bridge retainers in use today.

Suppose that we could cast and place in a tooth either a proximoclusal or a mesioclusodistal inlay attachment with an additional dovetail on the proximal surface near the gingival surface to resist removal of the casting from the cavity occlusally, in the direction of exit (Fig. 1): obviously, displacement of this inlay attachment would be impossible unless the gold forming the dovetail on the proximal surface were first cut away

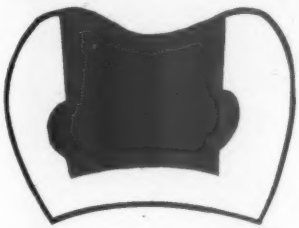

Fig. 1.—Inlay with proximal outline form which, if possible of execution, would represent positive mechanical fixation.

and the casting then lifted out in the usual manner.

This represents true mechanical retention or positive fixation. Any bridge to become loose must come away from the teeth in the direction of exit of the wax patterns and cast retainers from their cavities. From the standpoint of retention, that is the direction of greatest weakness. Certainly, this is no profound revelation; just a simple indisputable fact.

It is possible, by the method to be described, to make and place in abutment teeth gold bridge attachments with the general retentive outline just described. I have been making these attachments for practical cases in the mouth for seven years, and they are so secure that, even before cementation, their removal can be accomplished only by first removing the small metallic part that forms the retentive outline on the proximal surface.

This attachment principle marks a fundamental change in the mechanics now employed to retain fixed bridgework.

The making and placing of these locked retainers add no difficulty to the construction of any good mesioclusal or mesioclusodistal inlay. In fact, they can be made and locked much more easily and quickly than the less retentive, more destructive attachments that they replace. A quick simple method has been devised for adding the retentive part or lock to any inlay with a margin running axially on an axial surface of a tooth in a few minutes after it has been cemented to place.

Heretofore, improvements in cast retainers have been largely a matter of increasing the extent of the surfaces of opposed cavity walls to increase the surfaces to which the cement could adhere. That is one reason why the three-quarter crown and full crown are more retentive than a small inlay. The various technics with intricate grooves and with pins placed parallel to the direction of exit of the castings from the teeth, some of which are quite fancy, are all examples of the same effort. In all cases, the mechanics is the same: the retainers can be lifted easily from the teeth except for the attaching quality of the cement. Even in my control technic for precision inlay casting in which the retentivity of cast attachments is definitely increased by weighing the cristobalite and control powder on the automatic scale at 10 degrees above the temperature graduations recommended for individual inlays, there is no basic change in the mechanics of fixation.

The method is to place a tiny precision pin fixative or lock attachment in a precision cavity drilled on the axial

margin of a cast retainer, half in the gold and half in the tooth structure, at a right angle to its direction of exit from the tooth. (Fig. 2.) In other words, a pin which engages both the tooth structure and the gold retainer is placed on an axial margin perpendicularly to both the surface of the tooth and the direction of removal of the inlay from the cavity. Then, when the inlay has been placed in the tooth and the pin inserted, the inlay is securely locked to the tooth and it cannot be removed from its cavity until the lock pin has first been removed. The resistance to shear of a pin on an axial margin at a right angle to the direction of exit of an inlay affords genuine mechanical retention.

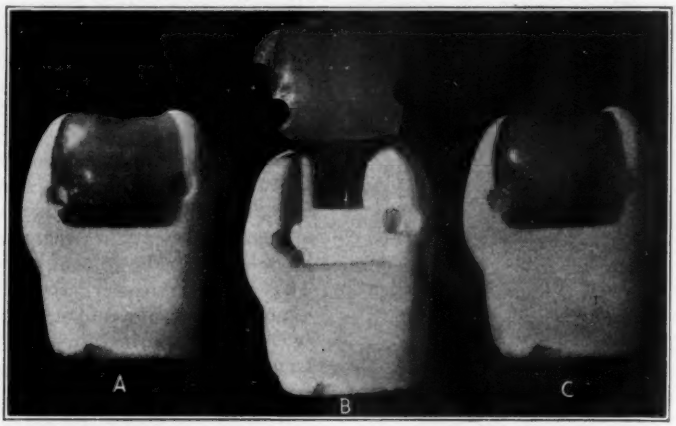

Fig. 2.—A, lock cavity preparation on margin of casting. B, resulting cuts in tooth and gold. The retention notches in the inlay and the tooth are to be noted. C, lock pin in place in tooth structure and casting. The retentive outline is now similar in form and function to the dovetail on the proximal surface in Figure 1.

A BRIEF REVIEW OF THE INVESTIGATIVE WORK

A short history of the evolution of this technic up to its final simplified and very practical state may prove interesting and enlightening.

My first attempts to lock in small attachments were made by drilling a small round cavity, half in the gold and half in the tooth structure, and then packing in amalgam. But amalgam did not have sufficient strength to resist the shearing of displacement forces and some of these small amalgam locks broke. Besides, they certainly did not enhance the appearance of the inlay.

Then I began to use gold foil, and after I had cemented bridges with small attachments, I malleted foil in these cavities. These held when the gold was thoroughly condensed; but the packing of the gold between the cemented inlay and the tooth wall spread them apart somewhat and later evidence of leakage appeared about some of the inlays. These bridges held securely, but I realized that dentists would never adopt the gold-foil method because of the disadvantage mentioned, and because the placement of gold foil made this procedure more difficult and required more time than the present method of fixing bridgework. All types of screws proved worthless biologically for marginal application because they wedged the margin of the inlay from the tooth, and technically, because of the great difficulty of manipulating such tiny screws.

Then I made tiny castings for tiny

round cavities, and this was highly successful from both the mechanical and the biologic standpoint. Many bridges that I have attached in this manner have remained in perfect condition for years, though the cast retainers supporting them would have been deemed entirely inadequate for retention by the ordinary method. In one instance, in which both upper bicuspids were missing on one side and a strong first molar remained adjacent to the space, I placed a semifixed bridge. It was fixed to a mesioclusal inlay in the molar, and the mesial end of the bridge carried a lug which rested in a groove in a distolingual inlay in the cuspid. The mesioclusal retainer was locked on its mesial surface in the manner just described.

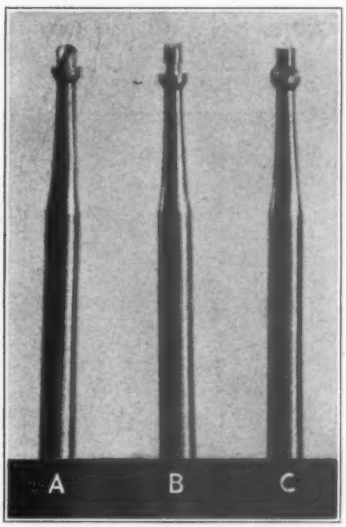

Fig. 3.—Three precision drills: A, starter; B, cylindricutter; C, beveler. The shoulders on the first two and the smooth cylinder projecting from the third each accurately limits the depth to which the drill can cut.

This bridge might be said to represent an abuse of this method of attachment. I placed it to test the efficacy of the principle under the most severe and unfavorable conditions and it is in use today, firmly fixed after more than five years of normal use.

But while the last method of casting tiny pins was mechanically successful, it was still quite impractical. Except for experimental purposes no one would take the time and care necessary to make, fit and cement such small castings.

The application of the locking principle had to be made so practical that any dentist could apply it in actually less time and with less difficulty than is required to make bridges by the cement-attachment method. This is now an accomplished fact. The idea of reversing inlay procedure and cutting a precision cavity to fit a tiny ready-made precision inlay pin occurred as the practical solution.

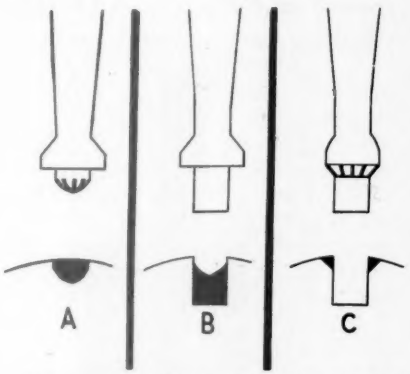

Fig. 4.—Three drills with section of cut of each immediately below it in black: A, starter; B, cylindricutter; C, beveler.

My early experiments and those of others in applying this idea by using various kinds of burs of the same size as clasp metal wire, much as porcelain rods were used years ago, were pretty crude and I would not have invited examination of the margins with pride. Besides it was a vexatious procedure as well as an imperfect one and I knew that it would never be acceptable to the profession today with our higher standards. But basically this adaptation of the method was correct and it is the one that has been developed

into the final technic, which is mechanically precise, and surprisingly quick and easy. It only requires about fifteen minutes to carry the whole locking procedure through to completion—lock cavity preparation, fitting and cementation of the pin—with a precise end-result.

Tiny gold pins were precision made. They are only 1.75 mm. in length, and 1.25 mm. in diameter, accurate to within 0.001 inch. Because one-half of the pin-head engages the tooth enamel near the gingival border, it was necessary to use a pin with a beveled head, to permit beveling of the cavity margins. The classical requirements of good dental service had to be fulfilled. Besides, from the biomechanical standpoint, a beveled head aids in securing true cavosurface pin marginal adaptation.

Fig. 5.—Enlarged view of handle pin.

Then a method of drilling precision cavities of the exact dimensions of the pin as to diameter, depth and surface bevel was devised. A series of three precision drills were designed, which makes preparing these little precision cavities one of the simple operations in dentistry.

In order to cut a cavity never exceeding the diameter of the pin, it was necessary to use a smooth-sided, end-cutting drill of equal diameter. But to start and maintain an ordinary flat end-cutter at an exact point, half on the gold margin of the inlay attachment and half on the tooth structure, was almost impossible because of the strong tendency of a flat drill to creep when applied half on the gold.

Therefore, drill No. 1, the starter (Fig. 3, A), with smooth sides of exact pin diameter and with a round-pointed cutting end, was designed.

This starter has three purposes:

1. With the round-pointed cutting end, it facilitates centralizing the cavity accurately on the margin of the retainer, to cut equally into the gold and the enamel.

2. By cutting a shallow cavity, it prevents any side creeping of the flat-end cutter, which is next applied.

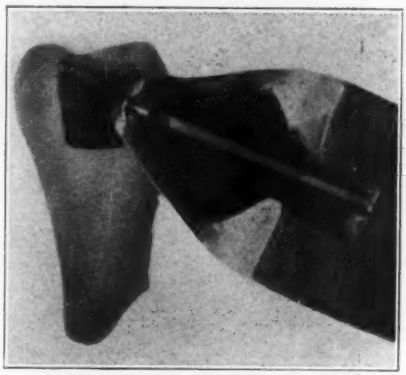

Fig. 6.—Beaks of wire cutter severing handle from pin in tooth.

3. In starting a cavity, it obviates an oversize cut such as a flat-end cutter in a loose handpiece might make. Pressure on the inclined planes of the starter point transforms this point into a truer running-end bearing, which keeps the drill on a constant axis and prevents side cutting beyond its exact diameter.

The point of the drill is centered on the margin of the inlay attachment about 2 mm. from the gingival angle perpendicularly to the tooth surface and is embedded until the smooth sides of the drill just enter the tooth structure and gold.

Because gold often cuts more easily than enamel, a little side pressure toward the tooth margin is often helpful in keeping the drill correctly centered as it is embedded. A smooth depth-limiting shoulder placed close to the cutting end of this drill stops it soon after it has started a shallow cavity, the diameter of the No. 2 flat-end cutting drill (Fig. 3, B), called the cylindricutter, because it cuts the full cylindrical part of the cavity.

The cylindricutter is placed in the shallow cavity at the same angle to the tooth before the engine is started, to prevent cutting a new path. The cavity started prevents side creeping of the cylindricutter when applied. The smooth sides of the drill limit the diameter of the cavity to the predetermined pin dimensions. Lateral non-cutting slots provide escape for débris.

In order that the cavity may be limited also to the exact depth desired, the cylindricutter has a smooth shoulder accurately spaced from its cutting end to prevent any cutting beyond the predetermined depth to which the pin reaches. Water dropped on this drill helps to dissipate the frictional heat. The drill is embedded as far as it can go, until its shoulder stops the cutting. When it is replaced to cut to its full depth, it should be placed in the cavity at the original angle to the tooth before the engine is started.

The second drill has a flat cutting-end. A point here would cut closer to the pulp without adding anything to its mechanical locking value. That is why drills No. 1 and No. 2 were not combined as a single pointed drill. Each fraction of a millimeter added to the depth of the cut is of biologic significance.

We have now cut a cylindrical precision cavity of exact pin diameter and depth.

Cutting the precision bevel on the margins of the cavity to conform to the beveled head of the pin completes the cavity preparation. The beveler (Fig. 3, C) was designed to cut the exact bevel of the cavity and absolutely no more. Various designs were tried, but all were liable to deepen or widen the accurate cylindrical cavity already prepared. The final design illustrated definitely limits the cutting to the desired bevel. It consists of a precision cylinder with smooth sides and end, to fit perfectly the cylindrical cavity already cut. This smooth cylinder also prevents any deepening or side cutting of the cavity except the surface bevel where the beveled knives are present.

The beveler is completely inserted in the cavity before the engine is started, at the same angle to the tooth at which it was originally drilled. The only possible cut is the marginal bevel.

The smooth-surfaced precision cylinder of the beveler has four purposes:

1. To facilitate placement of this cutting tool in the cavity for beveling at the exact angle at which it was originally drilled. In fact, it can enter only when in the correct position.

2. To prevent any side cutting of the cavity except the desired surface bevel.

3. With the smooth end of the cylinder, to prevent any deepening of the cavity.

4. With the smooth end, also to stop the bevel cutting at the exact point desired.

The beveler also provides the protective feature of obtaining fine marginal adaptation though the operator has failed to prepare the cavity thus far with the drills held at a perfect perpendicular to the surface of the tooth and gold retainer. When not exactly perpendicular, the cylindricutter may be stopped by contact of its shoulder only with tooth or gold, but the beveler, cutting all around the margin of the cavity, assures contact of the pin bevel with the entire cavosurface bevel which it cuts, and any microscopic part of the pin beyond it is easily dressed down to its intimate contact with the beveled margin of the cavity.

The beveler also removes any jagged enamel margins that remain from the earlier stages of preparation and assures finishing with a clean, smooth cavity margin.

This beveler presented a nice manufacturing problem. It was impossible to cut the beveled teeth right up to the smooth cylinder without cutting the sides of the cylinder and making it a side cutter which would enlarge the cavity. This was obviated by cutting teeth in a beveled ring first and then pressing this cutter on the smooth cylinder to exactly the correct distance from its end.

Sections of the three cuts made by the drills are shown in Figure 4. The cut with each drill is finished with very definite pressure on the shoulder against the tooth and gold surface to make sure that the drill has cut to its full dimensions.

It is superfluous to call attention to the necessity of using only true-running handpieces, especially angle handpieces, to cut accurate lock cavities or any other type of cavity.

After the cylindricutter has been embedded to its maximum, the débris is forcefully blown from the cavity, the knives are cleaned and the drill is used again with definite pressure. This is repeated until the absence of débris on the knives proves that the cut has been completed to its accurate maximum. This applies also to the beveler.

If, when fitting, the pin does not seat itself satisfactorily, probably the cut has not been completed as above. In that event, the cuts are repeated as outlined.

This method represents the simplest and strongest mechanical means of positive fixation of small castings by utilizing the resistance of a hard gold to shearing. But, in dentistry today, mechanics is not paramount. Significant it is that this technic fits perfectly into the mechanobiologic picture as painted by the old master, G. V. Black, enlarging the scope of usefulness of his classical preparations. It is particularly noteworthy that it is never necessary to deepen these conservative areas of preparation at any point to increase retention by this method.

One of the prime benefits of this technic is that it brings us back to the simple, sound fundamentals of cavity preparation for bridge retainers. Whether in football or dental service, success depends primarily on a thorough knowledge and practice of fundamentals.

It is hardly conceivable that this mechanical principle of marginal locking has never been used before. In fact, I have little doubt that it has been employed by some one else at some time if only in a haphazard manner. Therefore, I shall merely state that as far as I am concerned, it is an independent conception, not the result of seeing anything in the literature regarding it, and that, as far as I am aware, this is the first time a complete, perfected technic for making marginal fixation a practical precision operation has been presented.

A PRECISION FIXATIVE OF NEW DESIGN

Though the preparation of the precision cavity of exact pin dimensions had been developed to the ultimate in simplicity and accuracy, the technic was still not practical for universal use.

Until the last year of this research, tiny simple bevel-headed gold pins of the ordinary type were employed. The mechanical superiority of this locking principle had been positively proved and the practicality of cutting precision cavities to fit ready-made precision fixatives had also been conclusively demonstrated. But the use of ordinary pins of such minute dimensions presented such difficulties in practical work in the mouth that further investigative work was clearly necessary to make the practical application of this method 100 per cent simple and speedy from start to finish.

Because of their unusually small size and because their heads are so closely

adapted to the cavity margin when in place, it was most difficult to place these pins in their cavities and to check their fit, and almost impossible to remove them without mutilation after fitting.

Another objection to the use of simple pins was the almost unbelievable difficulty of trying to place extremely short, tiny pins when covered with cement. They must be grasped in the pliers by their short cement-covered sides, which makes their introduction into the cavity a most difficult procedure. Experience reveals this as one of the most exasperating operations in practical mouth work. It was soon recognized that few would endure all the aggravations attendant on the use of tiny pins of the ordinary type. Friends who cooperated in the clinical application of this development complained of the difficulties of manipulating the tiny pins. Obviously, this technic had to be easier and simpler, as well as more retentive, than any other to be of genuine value to the profession.

These ends were fully attained by the development of a tiny lock pin of new design which eliminated all the objections to the ordinary type of pin. The final evolution of pin design, the handle pin, is illustrated (enlarged) in Figure 5. This hard-gold handle-pin, accurate to within one-thousandths inch, has a slender projecting handle as long as the pin itself extending from the central part of the head, which makes its manipulation very simple. This handle is easily grasped in the pliers and the placement and removal of the pin, though it is flush with the cavity, are accomplished in an instant. This improved pin lock also affords a convenient and clean handle free from cement and takes all the difficulty out of the cementing operation.

The fact that the handle is of much smaller gage than the head of the pin and well spaced from the margin of the head has another decided advantage. The handle can be snipped off with a small wire cutter with beaks running at an acute angle to the pliers' handle, as soon as the cemented pin has been introduced into the cavity, without any danger of distorting the marginal adaptation of the pin to the cavity by compression of the beaks of the cutter. (Fig. 6.) The severed handle may be added to the hard casting gold and is not wasted.

Another helpful feature: the design of the handle pin is such that its heavy body causes it to lie always with its handle obliquely upright above the surface of the tray so that it can be easily picked up with the pliers. It is not possible for the little pin to come to rest with the handle in any but a convenient position.

This handle pin removed the last hurdle to the sequence of complete practicality and makes it possible to prepare the lock cavities and fit and cement the pins in a matter of minutes. Now simple retainers can be completed and securely locked to place in much less time than is required to make the more difficult retainers that they replace and with far greater assurance of positive fixation.

Because of the accuracy with which the pin fits the cavity, all débris must be expelled from the cavity, with a strong blast of air, before the fit is verified and, for the same reason, fairly thin cement is used for the pin.

After the pin has been finally introduced into the cavity for cementation, the handle is immediately cut off and the pin is forcefully pressed to place.

We must be sure to wait until we are absolutely certain that the cement has completely set before the tiny nub left from the handle or the margins are finished. Then only sandpaper disks should be used for this purpose.

PRACTICAL APPLICATION IN FIXED BRIDGEWORK

This technic is not presented as a

panacea for fixed bridgework failures. I do not contend that it is necessary to lock every bridge made with this technic. In cases involving only a single pontic, wherein extensive caries of abutments necessitates large cast retainers, it may not be necessary. However, for the last five years, I have locked practically every bridge that I have made, with the result that, during that time, I have not suffered the embarrassment of a single loosened attachment.

I do wish to stress the thought that the superior retentiveness of this method should never be utilized as justification for compromise in cavity preparation for the retainers.

The following are examples in which smaller attachments can be employed with complete assurance of security if cavities are properly prepared and good castings made.

When the second bicuspid and adjacent first molar are missing, a properly prepared and locked mesioclusal inlay in the second molar will securely retain the bridge on the posterior aspect. I often lock both the buccal and lingual margins on the mesial surface in an instance like this because it requires little time and adds much to the security of this conservative attachment.

I find it advisable to insure 95 per cent of my bridges by locking them. From the practical standpoint I regard the little time required as very cheap insurance indeed. It is especially useful in an instance where a fixed bridge is indicated and where the abutments are on sound teeth or on teeth with fillings of ordinary proportions.

For the anterior retainer of this bridge, a mesioclusodistal inlay in the first bicuspid, locked on the mesial surface for convenience, affords positive fixation.

When both bicuspids and the adjacent first molar are missing, a mesioclusodistal inlay locked mesially in the second molar will suffice as the posterior retainer. In this case, I should certainly recommend locking at least one axial margin of a three-quarter crown on the cuspid. This can be done on the axial margin of either the mesial or the distal surface or, for greater retention, on both. Access for locking anterior and first bicuspid retainers is usually as easy on the distal as on the mesial surface.

A proximoclusal inlay will also serve as the major soldered retainer of a semifixed bridge with one pontic if it is locked in place. I prefer also to lock the minor unsoldered proximoclusal retainer, to be completely safe, provided it does not involve the distal surface of a tooth posterior to the first bicuspid. Then, if desired, a mesioclusodistal inlay can be placed and locked on the mesial surface.

Cuspid-to-cuspid bridges with three-quarter crown attachments are far more secure if the three-quarter crowns are locked to the teeth. Posterior three-quarter crowns are also easily locked on the mesial surface, just as one would lock a mesioclusal casting.

In posterior teeth, the mesial surface is most often used because of easier access. For the same reason, the buccal margin is usually preferred to the lingual.

ABUTMENT CAVITY PREPARATION

The cavity preparation recommended is that of G. V. Black, with the margin or margins which will be locked well-extended for access, and with decided dovetails approaching somewhat a T shape. No increased depth of the proximal box is necessary in this technic. In fact, it should be scrupulously avoided. However, it is obvious that the retentiveness of slice preparations is also magnified by locking.

I prefer that the wall of the cavity, the cavosurface margin of which will be locked, be prepared with its plane approximately perpendicular to the surface of the tooth.

If one desires to obtain the strongest possible anchorage consistent with the minimum of tooth destruction, the entire proximal box should be cut only to a depth of 1 mm. or less, except where the axial wall joins the buccal or lingual wall, the cavosurface margin of which will be locked.

To illustrate: Picture a box cavity on the mesial surface of a bicuspid which is planned to lock on the buccal margin. The axial wall need not be cut to a depth of more than 1 mm. where it joins the lingual or gingival wall, or at any other point except where it joins the buccal wall at the axiobuccal line angle, where the maximum depth should not exceed 1.75 mm. to engage the full length of the lock pin.

Evidently, the concept that retentive power is dependent on the extent of mutilation of sound tooth structure is now a thing of the past.

I always postpone preparation for the locks until the bridge has been cemented to the abutments and the cement is fully hardened, to reduce the possibility of unseating the retainers while the lock cavities are being prepared. This procedure must be followed. Except when placing lingual locks, I interpose a cotton roll or piece of rubber between the pontics of the bridge and the opposing teeth and prepare the lock cavities while the patient occludes the teeth, holding the bridge firmly seated. These precautions apply also when individual inlays are locked.

It is also important that the entire locking procedure be completed before the porcelain pontics are cemented to the bridge because pontics reduce access to the margins for the locking operation.

This technic may also be used to secure bridges already placed if they loosen before caries sets in.

ADDITIONAL USES OF THIS TECHNIC

This technic also has a wide variety of advantageous uses beyond the scope of fixed bridgework. In fact, it is very valuable in retaining any inlay that is subject to more than ordinary displacement forces.

I frequently find it desirable to lock inlays that receive the retentive bearings of clasps. Here, the added displacement forces of function and removal of the partial denture must be resisted by the inlays. I recently had occasion to clasp a lower molar with no anatomic undercut, but containing an old buccoclusal amalgam filling. This filling was replaced with a hard gold inlay with a small depression on its buccal surface to receive the retentive bearing of the clasp. This inlay was then locked on an axial margin of the buccal surface to prevent its dislodgment by the clasp.

The handle pin may also be used as an independent gold inlay to restore small carious areas on the buccal, labial, lingual and even the occlusal surfaces if the cusps are low. In this way, a gold inlay can be completely finished in one sitting as quickly as an amalgam filling. Either pit or smooth-surface cavities can be restored if they are not too large.

For pit cavities on occlusal surfaces with low cusps, I first flatten the area about the pit with the flat end of a cylindrical stone which is just a little larger than the shoulder of the first two drills, so that the shoulders will not stop the cutting of these drills too soon by contact with the cusps. Of course, no sharp angles should be left on the occlusal surface.

In some instances, if there are no teeth adjacent, these gold inlays may be placed on proximal surfaces too.

When the entire occlusal surface of a posterior tooth must be restored with gold and the remaining walls of the cavity running axially are so short that retention by the ordinary method is hazardous, and further mutilation of tooth structure for crowning is undesirable, a lock or

locks placed on the short axial margins of the inlays makes them even more secure than a full cast crown and conserves time and tooth structure as well. This technic is also ideal for locking inlays for opening the bite in an unusually nondestructive manner (to be described at a later date).

The technic is particularly useful for locking the inlays that retain Neurohr or Chayes bridges in order to combat the extra displacement forces of function and withdrawal which are exerted directly on these inlays. Locking them to place makes maximum security compatible with minimum tooth destruction.

Because mesiolingual and distolingual inlays for anterior teeth that receive rest lugs for semifixed bridges or partial dentures are usually small in relation to all that depends on them, I make it a rule to lock them. These inlays exit from their cavities in a lingual direction and therefore are locked on their gingival margins. Locking here, as in the case of locking the axial margins on posterior teeth and anterior three-quarter crowns, is always effected on a margin running parallel to the direction of exit of the inlay.

Again, the margin to be locked, the gingival in this case, should be extended well, to provide sufficient access to prepare the lock cavity perpendicularly to the surface of the tooth. The lock is placed on the gingival margin about 2 mm. from the labiogingival angle of the inlay.

The cement must thoroughly set and the inlays be held very firmly in place while the lock cavities are being prepared. These independent inlays should always be cemented to the teeth and the locking operation should be completed before any other part of the semifixed bridge has been cemented, and while there is maximum access.

This is only a partial list of the additional uses of this technic, but they expand with the ingenuity and resourcefulness of the operator.

POSSIBLE OBJECTIONS

It is only natural for dentists to look for possible shortcomings in a technic that represents such a radical departure from established procedure.

One dentist was concerned about the greater difficulty of removing bridges locked in place, should it be necessary. Bridges better secured by this technic are even more easily removed than bridges retained by larger attachments, held only by cement.

When a locked bridge must be removed, the tiny pin lock is first drilled out. This is quickly accomplished with the first two drills used for preparing the little cavity. Then we have only to remove relatively smaller and less secure retainers held in place by cement, and we have a place for grasping them for removal besides.

Another operator wondered if the little lock cavity might weaken the tooth. Perhaps, but not one-tenth as much as the more destructive type of preparation it replaces.

Another operator suggested possible encroachment on the pulp. But in this technic, employing resistance to shear most superficially on the tooth, the box of the retainer cavity is not deepened at any point and the pin enters the tooth to a maximum depth of only 1.75 mm. from the surface. Suffice it to say that many of the proximal boxes that we prepare almost daily in vital teeth go deeper than that.

The protective depth-limiting feature of each of the three precision drills is so effective that the danger of encroachment on the pulp has been completely eliminated. It is almost impossible to cut too deeply.

As far as I am aware, the only shortcomings of this lock are those self-imposed by the dentist, such as: failure to

extend retainer margins properly for access; failure to permit the cement holding the retainers to set completely before starting preparation for the lock cavity; failure to prepare lock cavities equally in the gold and tooth structure, and premature cementation of porcelain pontics, which reduces accessibility.

ADVANTAGES OF THE TECHNIC

This technic has mechanical, biologic, economical and esthetic advantages:

(A) Mechanical advantages.—1. It provides more positive fixation. 2. It permits greater simplicity of retainer design. 3. It can be used to retain any inlay which must resist unusual displacement forces, such as inlays receiving the retentive bearing points of clasps. 4. It requires no change in the basic design of our simple, standard tooth preparations (Black).

(B) Biologic advantages.—1. It conserves tooth structure and pulp. 2. It reduces the danger of caries under loosened attachments. 3. The use of simpler attachments leads to improved quality of workmanship in retainer construction. 4. It requires no deepening of retainer cavities.

(C) Economic advantages.—1. It saves time and energy by utilizing less complicated preparations for retainers. 2. It requires less gold for the smaller, simpler attachments. 3. It reduces the need for remaking loosened bridges. 4. It obviates large destructive preparations and prevents loosening of bridges. 5. It requires no expensive or elaborate equipment.

(D) Esthetic advantages.—1. In more conservative attachments, there is less display of gold.

CONCLUSION

To feel in your own hands the resistance to displacement of these uncemented locked-in attachments is more convincing than words. So that anyone can sense the effect of mechanical fixation I have prepared an uncemented inlay for a metal die for my clinic which follows. Though this casting enters and exits from the cavity as gently as a precision piston from a precision cylinder, when the lock pin is placed, it resists forceful withdrawal though the large die is grasped in one hand and the generous sprue on the inlay is grasped in the other. This strong mechanical retention is not used in place of the customary cement retention, but in addition to it. In other words, this technic represents retention plus.

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ASSOCIATION OF DENTAL CARIES IN CHILDREN WITH SEX, AGE AND ENVIRONMENT

By HILDA KAISER, B.S., and BION R. EAST, D.D.S., New York, N. Y.

THE evaluation of the rôle of vitamin D in dental caries prevention and control is an example of opposing opinions among investigators regarding the etiology of that disease. It was thought worth while to investigate the possible correlations of caries with certain environmental factors which might influence the vitamin D produced in children's bodies by exposure to the sunshine. The factors selected for this purpose are mean annual hours of sunshine, mean winter temperatures and latitude.

Data collected by the United States Weather Bureau furnish dependable information regarding climatic conditions.[1]

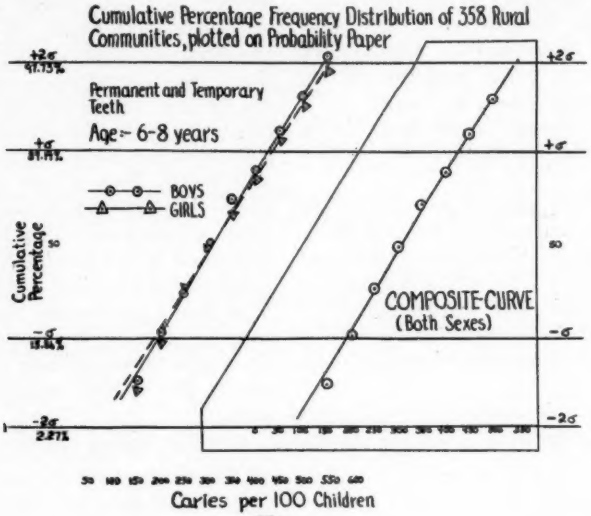

Figure 1.

In 1934-1935, the United States Public Health Service and certain state units of the American Dental Association examined one and a half million school children. The resulting published data yield valuable measures of caries rates in various localities. In this study, these data were used for comparing the caries rates of different areas. Therefore, it was necessary to determine whether lack of uniformity in examining technic had introduced errors which would

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Read before the Section on Histology, Physiology, Pathology, Bacteriology and Chemistry (Research) at the Eighty-First Annual Session of the American Dental Association, Milwaukee, Wis., July 18, 1939.

TABLE I.—FREQUENCY DISTRIBUTION OF CARIES RATES IN 358 COUNTIES

TABLE I.—FREQUENCY DISTRIBUTION OF CARIES RATES IN 358 COUNTIES
(PERMANENT TEETH)

Caries Rate (Cavities per Hundred Children)	358 Counties* (95,798 Boys) Age 6-8	358 Counties* (92,532 Girls) Age 6-8	Cavities per Hundred Children	358 Counties* (111,133 Boys) Age 9-11	358 Counties* (109,406 Girls) Age 9-11	358 Counties* (89,674 Boys) Age 12-14	358 Counties* (83,165 Girls) Age 12-14
0 — 24	7	7	0 — 49.9	4	3	0	0
25 — 49	52	39	50 — 99.9	25	16	6	3
50 — 74	85	53	100 — 149.9	58	45	10	9
75 — 99	60	74	150 — 199.9	71	67	38	24
100 — 124	67	65	200 — 249.9	75	75	43	33
125 — 149	33	44	250 — 299.9	63	70	48	39
150 — 174	25	31	300 — 349.9	37	45	50	52
175 — 199	13	23	350 — 399.9	18	24	40	47
200 — 224	8	7	400 — 449.9	3	10	40	35
225 — 249	6	9	450 — 499.9	3	6	34	37
250 — 274	2	4	500 — 549.9	0	1	21	24
275 — 299	0	0	550 — 599.9	0	0	13	23
300 — 324	0	1	600 — 649.9	0	0	7	12
325 & up	0	1	650 — 699.9	0	0	4	8
			700 — 749.9	1	0	1	7
			750 & up	0	1	3	5
Average number cavities per hundred children (arithmetic mean)	97.3 ±2.6	110.0 ±2.9		218.0 ±4.7	240.0 ±5.0	348.5 ±7.3	384.0 ±7.7
Standard deviation	50.0 ±1.9	55.0 ±2.1		90.0 ±3.4	95.0 ±3.5	138.0 ±5.2	145.0 ±5.4

*Identical counties in all distributions.

invalidate the data for our purpose.[2]

This paper presents a statistical analysis based on the caries rates of three age groups of rural or semirural children of each sex, preliminary to future reports involving these caries rates and the previously noted climatic factors. The 296,605 boys and 285,103 girls involved in this analysis resided in 358 counties of twenty-four states.

In the Public Health Bulletin, the items for each community are given as the number of cavities, fillings and extractions per hundred children. The

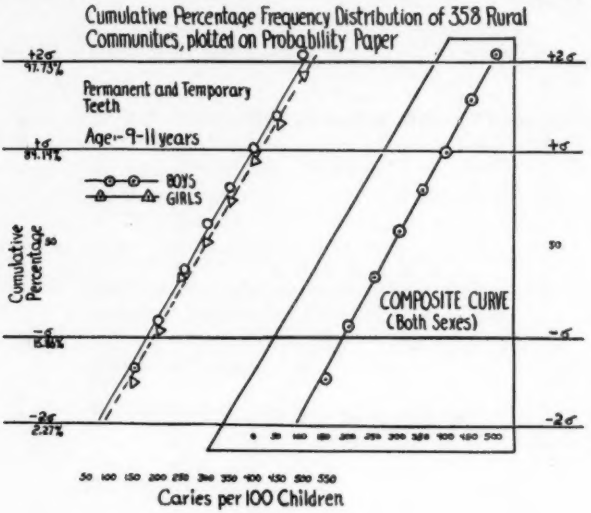

Figure 2.

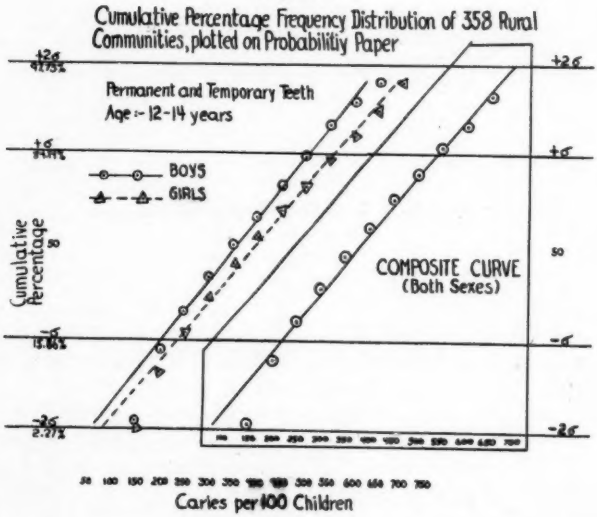

Figure 3.

TABLE 2.—FREQUENCY DISTRIBUTION OF CARIES RATES IN 358 COUNTIES
(PERMANENT AND TEMPORARY TEETH)

Caries Rate (Cavities per Hundred Children)	Age: 6-8		Age: 9-11		Age: 12-14	
	358 Counties* (95,798 Boys)	358 Counties* (92,532 Girls)	358 Counties* (111,133 Boys)	358 Counties* (109,406 Girls)	358 Counties* (89,674 Boys)	358 Counties* (83,165 Girls)
0 — 49.9	0	0	0	1	0	0
50 — 99.9	8	4	4	3	4	3
100 — 149.9	16	15	25	18	6	7
150 — 199.9	38	34	39	42	35	21
200 — 249.9	47	61	64	62	37	32
250 — 299.9	70	64	71	59	47	40
300 — 349.9	69	51	59	62	52	49
350 — 399.9	34	50	45	46	47	45
400 — 449.9	39	38	29	35	39	42
450 — 499.9	22	20	10	16	33	32
500 — 549.9	10	11	6	8	28	28
550 — 599.9	2	5	5	5	11	23
600 — 649.9	2	3	0	0	7	15
650 — 699.9	0	1	0	0	3	10
700 — 749.9	0	0	0	0	4	6
750 & above	1	1	1	1	5	5
Average number cavities per hundred children (arithmetic mean)	306.5 ±5.8	313.0 ±5.6	292.0 ±5.7	301.0 ±5.8	361.5 ±7.3	394.0 ±7.6
Standard deviation	110.0 ±4.1	107.5 ±4.0	108.0 ±4.0	110.0 ±4.2	139.5 ±5.2	145.0 ±5.4

*Identical counties in all distributions.

caries rates of each of 358 counties were determined from the original data by totaling the cavities and fillings in the temporary and permanent teeth and the number of extracted permanent teeth. Each extracted tooth was rated as one cavity. Deducting the number of cavities and fillings in the deciduous teeth from that total gave the caries rates for the permanent teeth only.

These arrays of 358 county caries rates for each of twelve age-sex groups were arranged in frequency distribution tables having class intervals of fifty cavities per hundred children for all groups except the permanent teeth 6-8 years of age groups, where the class interval was twenty-five cavities per hundred children. The arithmetic mean, standard deviation of each group was determined by the usual formulae, together with their respective sigmas. (Tables 1 and 2.)

The frequency distributions as they occur between ±2 sigmas from their respective means are plotted on probability paper in Figures 1, 2, 3 and 4. A normal distribution of rates would, by this technic, result in a straight line. The distributions in the series are normal, or nearly so.

In these data, differences in examining technic are apparently normally distributed. They tend toward uniformity. In the absence of any reasonable hypothesis suggesting that this distribution of examining technic is associated with the enumerated environmental factors, it may be reasonably assumed that there is no such association and that any variables in technic of examination are uniformly distributed among the other variables.

The differences between the mean caries rates of each of the various sex-age groups have been determined. The significance of the differences is also given. These determinations have been made for each group, being based on the caries rates of permanent and temporary teeth taken together, and also on the rates of the permanent teeth alone. (Figs. 5 and 6.) When the means of the caries rates are based on temporary and permanent teeth, differences appear in each age group, although the difference in the two earlier ages is in itself of little

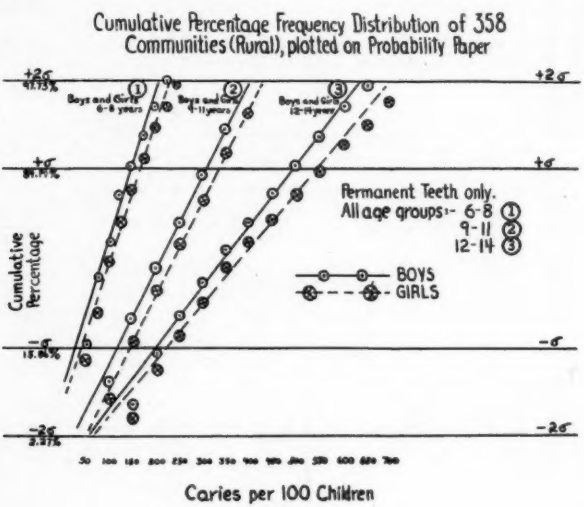

Figure 4.

statistical significance. That of the age group 12-14 years is highly significant, and the series taken as a whole is consistent with the view that real differences exist between the boys and girls of each age group, increasing with age. The same conclusion results from an analysis of the permanent teeth only, the differences being progressive with age, but, in this case, each difference is statistically significant by itself.

SUMMARY

The frequent distribution of caries rates in 358 counties of twenty-four states based on white boys and girls of three age groups residing in rural or semirural areas closely follows the normal law of distribution except as influenced by variables which in themselves are likewise distributed according to the same law. The data appear, therefore, to be suitable for comparing the caries rates of one group with another. They also seem adequate as the basis for determining the correlation of caries rates with other variables.

The mean caries rates of these white children, residing in rural or semirural areas of 358 counties of the United States, were determined. There are significant differences at each age between the mean caries rates of the boys and girls, whether the permanent teeth only are considered or the permanent and the deciduous teeth are used as the basis. In the same age group, the girls have more caries than the boys, and these differences increase with age.

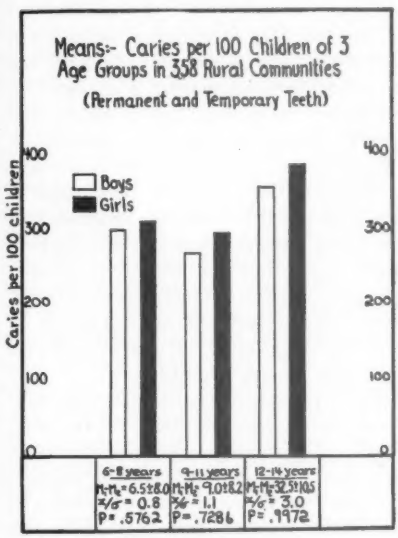

Figure 5.

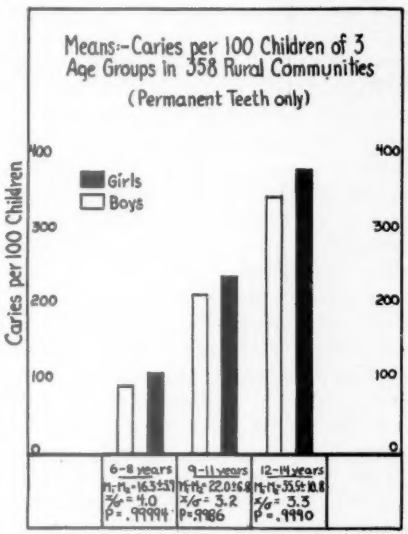

Figure 6.

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2. U. S. Pub. Health Bull. 226, 1936.

MANAGEMENT OF UNERUPTED AND IMPACTED CANINES

By JOHN V. MERSHON, D.D.S., Sc.D., and JOHN H. GUNTER, D.D.S., M.D.,
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IN the past, there has been no practical routine procedure for the management of impacted and unerupted maxillary canines. Prior to the use of the roentgenogram, many of these teeth were never discovered, and the general practitioner has seen many instances in which they have erupted either labially or lingually during all periods in life. Ever since the introduction of the x-rays, many such teeth have either been allowed to remain in their unerupted, abnormal positions or they have been extracted. In either case, when a space remained in the arch, an artificial substitute has been inserted.

In recent years, a method has been developed, through the joint services of oral surgeon and orthodontist, whereby unerupted maxillary canines are directed into their usual position in the dental arch. Neither the oral surgeon nor the orthodontist can perform this service alone: it depends upon their cooperation. The first step is the responsibility of the general practitioner, for it is he who has the opportunity of keeping watch over the developing denture and making the diagnosis. X-ray studies should be made as early as the ninth or tenth year if normal eruption of the maxillary canine is not perfectly evident.

Early recognition of the malposition of these teeth assists greatly in bringing them into proper position. This does not mean that they cannot be brought into place later. They have been brought into position in patients as old as 40 years of age. But the period in which the alveolar process that supports these teeth is in the process of development and the roots are forming is the ideal time as regards results.

DIAGNOSIS

The deciduous canine may or may not be present and there may or may not be room for the tooth. The opposite maxillary canine may also be absent and double impactions are not infrequent. The proximal teeth may be in correct vertical position or they may have a mesial or distal inclination. Protrusion of the second incisor is one of the best diagnostic signs that the canine is labially placed. A palatal inclination of the crown would indicate an impaction in the palate; a labial inclination, an impaction in the labial position.

The x-ray exposures necessary to make a complete diagnosis are: (1) a small dental film through the median line; (2) one through the canine region; (3) another through the premolar and first molar regions, and (4) a bite film showing the anterior two-thirds of the hard palate. These studies should reveal the tooth in its entirety and indicate its position. The germ of the canine is rarely absent.

This x-ray study should establish: (1) the presence or absence of the tooth; (2) the extent of calcification of the tooth; (3) the integrity of the crown; (4) the character of root formation; (5) the relation of the unerupted tooth to other teeth and the integrity of these teeth; (6) the character of the surrounding

tissues, and (7) the relation of the unerupted tooth to such anatomic structures as the maxillary sinus, the floor of the nose, the nasopalatine canal and the floor of the orbital cavity.

The impacted tooth may be associated with cystic disease, odontoma, rarefying osteitis, osteosclerosis, cementosis, heterodontia, hyperdontia, hypodontia and cleft palate. It may cause resorption of the roots of adjacent teeth resulting in pulpitis (rarely), followed by death of the pulp and focal infection. Finally, it may, by pressure on nerve filaments, be the cause of local or referred pain and, in rare instances, cause such bizarre nervous phenomena as mental fatigue, amblyopia and psychasthenic states.

After diagnosis, the procedure varies according to the individual patient. Maxillary canines that are abnormally placed palatally present a problem quite different from those which are abnormally placed labially.

In accordance with conditions, the surgical exposure of the tooth may be performed: (1) before the arch has been expanded and space has been created to receive the tooth; (2) during the expansion process, or (3) after the necessary space has been obtained.

The selection of the oral surgeon is important. He must be one familiar with the technic of opening and exposing the crowns of these teeth and he must be able to insert a pin so that the orthodontist can have something to which to attach an appliance.

A preliminary visit to the oral surgeon should be made so that he may review the diagnosis, study the temperament of the patient and explain to the parent the nature of the operation. Complete cooperation is imperative. An uncooperative child presents a problem which may be a contraindication but, fortunately, this is seldom true at the age at which this operation is recommended.

When the time for the operation arrives, it is desirable that the stomach be empty in order to insure rapid absorption of the drugs administered, and in case analgesia or light anesthesia becomes necessary. Premedication with sedative drugs and full doses of atropine for the purpose of drying up the saliva are insisted upon. Psychic comfort and a dry mouth are essential in this operation.

ANESTHESIA

Obviously, local anesthesia is imperative, as general anesthesia would require hospitalization. A 2 per cent solution of procaine, with 1:50,000 epinephrine is preferable. Perfect anesthesia and maximum hemostasis, which are very necessary, are obtained by the infra-orbital block method and infiltration on both the labial and palatal aspects. A prolonged deep anesthesia always results if this technic is followed.

EXPOSURE OF THE TOOTH

A circular or elliptical incision is made through the soft tissues over the crown of the tooth. The incision may be entirely on the labial aspect or entirely in the palate, or it may include the alveolar margin, the site depending on the position of the tooth. The incised piece of tissue, together with the periosteum, is removed. Next, a series of holes are made through the cortical bone around the periphery of the incision, with a spear drill in the engine. The bone which has been outlined in this manner is then pried out with an elevator. With a curet and a round bur, all bone is removed over the greatest diameter of the crown up to the neck of the tooth, including the incisal tip. This is very important.

INSERTION OF THE PIN

With a small round stone, an opening is made through the enamel at the most accessible point in the crown. At this time, the wound is isolated and flooded with a 1:1,000 solution of epinephrine for the purpose of additional hemostasis. The wound is then thor-

oughly dried and the dentin entered with a No. 1 round bur to the depth of approximately 1.5 mm. If necessary, this may be supplemented with a No. 700 tapering fissure bur. It is necessary that no blood or saliva be allowed to contaminate the opening in the tooth in which the pin is to be inserted. A good crown and bridge cement is mixed to the proper consistency and is carefully worked to the bottom of the opening. The pin is then inserted with the loop placed in the most advantageous position for the orthodontist.

These pins are made of 0.022-gage wire. One end should be threaded for the purpose of retention; the other end bent into a loop for the purpose of attaching either a spring, directly, or a wire tied to a spring. The pins should be made of one of the good gold-platinum alloys.

CARE OF THE WOUND

The cement, after partially setting, is covered with varnish and, after a minute or two, medicated gauze is packed in the wound before it has become moist with saliva. One-quarter inch plain gauze in which is incorporated an antiseptic, anesthetic paste is used. This paste has a petrolatum base carrying one of the slowly soluble local anesthetics, thymol iodide, guaiacol, acetyl salicylic acid and balsam of Peru. As the paste becomes somewhat hardened, it prevents saliva from entering the wound, and granulation can proceed readily beneath it. This packing should not be removed for a week or ten days, or until it becomes loose in the wound. Repacking is rarely necessary, for when the first packing is removed, the orthodontist can proceed with the attachment to the loop. No matter how much bone has been removed, and even when bone is left exposed around the margins of the wound, there is no after-pain, little or no swelling of the face and no interference with the normal activities of the patient. Intermittent application of cold to the face for an hour or two as the anesthetic begins to wear off may be advantageous.

As for the orthodontist, his problem of handling these maxillary canines varies according to their positions. When the unerupted tooth is labially misplaced, the crown frequently exerts pressure upon the root of the maxillary second incisor, causing the root to be moved lingually and the crown labially.

The correction of the position of the labially placed second incisor should never be undertaken until the canine has been brought into its proper position and away from the root of the second incisor. If such correction is undertaken before the canine has been brought down, pressure on the second incisor will force the root of this tooth against the enamel of the misplaced canine, causing resorption of the root of the second incisor. The pressure put on the canine with an orthodontic appliance must be away from the root of the second incisor.

Whether labially or lingually impacted, these teeth are brought into position by the application of force from an orthodontic appliance. The chief precaution is the avoidance of pressure in excess of that necessary to cause the tooth to move. If the pressure is continuous or if too much force is exerted, the tooth may be devitalized. We must keep in mind that it is a biologic process that causes teeth to change position and not the force of the appliance used.

Any orthodontic appliance which one is accustomed to use and whereby gentle pressure can be exerted in the direction that the tooth is to move can be adapted to this purpose.

Frequently, maxillary canines, although in correct position, are unerupted several years after the usual time for eruption. If the oral surgeon is instructed to remove soft tissue or bone, according to the case, many of these teeth will erupt without further assistance, provided this aid is given at the time when these teeth

would normally erupt. If the operation is delayed beyond this time, they may be slow in erupting or may fail to erupt.

Even when not in absolutely correct position, the tooth may, if obstructing tissue is removed, move in the proper direction without orthodontic assistance.

When the maxillary canine is deeply seated, it may be wise to perform two operations: one to eliminate tissue resistance; the second, which may be performed a year or two after the first, for insertion of the pin. The development which usually occurs during this interval allows a more advantageous placing of the pin.

CONCLUSION

The object of this paper is solely to point out that impacted cuspids need no longer be lost through extraction; that the disadvantage of having the patient wear artificial teeth can be eliminated, and that the teeth, in most instances, can be brought into place and the dental arch can develop normally.

The details are presented so that the reader, through his own analysis, can judge whether this is a feasible procedure. Explanations are given so that he may understand what the problem is and our method of solving it.

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PHLEGMONS, INCLUDING FASCIAL SHEATH INFECTIONS, OF THE FACE AND NECK OF DENTAL ORIGIN*

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THE use of the term "cellulitis" will be avoided in this paper because there seems to be little unanimity in its use to designate any one type of infection. Similarly, the term "Ludwig's angina" is too all-inclusive. Without doubt, it is a common experience of the clinician to decide for himself, at some time in his career, that clinical medicine identifies itself best by strictly observing concepts which are unitarian and fundamental, and by applying these in a practical manner in mathematical sequences or combinations. That a departure from such principles often leads to confusion, is portrayed vividly by the bewildering mass of clinical writings on pyogenic infections of the soft tissues of the face and neck.

At least to this date, substitutes for an intimate knowledge of morphology, physiology, pathology and their interrelated sciences are not short-cuts to clinical acuity, but are, instead, hazardous detours.

These infections demand our greatest skill. And despite the fact that we have this skill, not infrequently, we reconstruct such cases to our own mortification at having been too shy, too brave or al-

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Presented before the American Society of Oral Surgeons and Exodontists, Milwaukee, Wis., July 15, 1939.

together wrong in their management! Just these experiences serve to maintain our awareness of the art which this practice of medicine is.

If any generalization is to be made, it is that these infections have one feature common to the whole group; namely, a type of progression of pathologic processes which is in itself an entity for each case.

In dealing with such infections, either in their earliest or in more advanced stages, we must contend with processes which can act at any time as if there were no actual barriers against their extension and will differ in their virulence as the focal site of each differs in its morphologic structure and bacterial flora. Should the suppuration spread by contiguity of structure through or along lymph and blood vessels, or along fascial planes—and these routes are readily accessible separately or simultaneously—a series of complications follow which are sometimes as unique as their origin is complex. But before this leads to the impression that the prognosis in such cases is as a rule hopeless, it should be emphasized, too, and with certain reservations, that some of our worst cases recover. Conversely, there are others which do not appear to be fatal until a change in the status of the patient occurs just before death becomes inevitable.

A sketch has been presented summarily of unit forces and problems. The individual patient and the individual doctor each represent another, but less obvious factor in favor of or against the eradication of this type as well as of other types of infectious diseases: the patient in that he is or is not physically and mentally equipped to withstand a bacterial invasion; the doctor in that with or without conscience he can be an instrument either for good or for evil.

Finally, recent physiotherapeutic and chemotherapeutic discoveries are helping us to control certain suppurations which were previously without bounds. These measures should be used only if and when they are indicated in selected cases, and should not be administered in the fashion of a mystic ritual.

Since, as Mosher so aptly states it, these infections have their greatest single source "in or about the tonsils," the mouth, soft palate and pharynx most commonly give evidence of this incidence in the history of the patient or by objective signs of inflammatory changes. Consequently, interpretations of the pathogenesis and pathology are quickly restricted in scope.

These inferences are concise. They guide us in establishing a diagnosis. They serve as points of departure toward rationalization in therapy throughout the course of the infection.

Emphasis in this paper is laid upon those infections which originate in the lower jaw and secondarily affect the neck. Paranasal sinus and temporal bone infections also reach the soft tissues of the face and neck, and must not be overlooked as focal points, even when there are no obvious indications of their rôle.

Mucous membrane "portals of entry," through which irritants often gain access to vulnerable tissues, hide their guilt by a surface that is normal in appearance. In such instances, cases of deep neck infections present additional problems in diagnosis and treatment.

Having determined all of these factors, the real difficulty arises in planning a surgical or non-surgical solution. In this respect, after instituting whatever measures seem to be indicated by the general reaction of the patient to the infection and by the presence or absence of other devitalizing or chronic debilitating diseases, the answer, at this time, lies partly in evaluating the probable routes of extension and its consequence, the local lesion. As was mentioned before, an obviously inflammatory mass in the soft tissues of the face or neck must have resulted from an irritant acting nearby and extending by contiguity of

structure, or acting remotely and extending by way of the lymph or blood vessels. In the first instance, signs of ulcerative or even gangrenous processes are usually prominent. In the latter groups, these signs can be less evident, so that only by careful observation for periods of hours or days is it possible to state with some certainty the nature of the swelling. Attention is again directed to these basic considerations, because our treatment, and perhaps our results, will be determined thereby.

APPLIED ANATOMY OF THE FLOOR OF THE MOUTH

It would be presumptuous to give here a discourse, in the time allotted, on detailed anatomy. What will be outlined are matters upon which our attention is focused in the laboratory and then at the bedside. These concern a number of connective tissue or fascial regions into which dental infections particularly enter. We label these as potential spaces and compartments, some of which are broad avenues, while others are enclosed almost completely by the adjoining muscles, ligaments, bones and cartilages, because of their ready distention by inflammatory exudates. For practical purposes, five such planes may be defined. They are disposed in layers as follows:

First plane (or "space") between the skin and the platysma muscle: This space may become involved directly from without, including among a number of affections that of erysipelas, or indirectly from within when deeper infections extend to the surface of the neck. Reticular and tubular lymphangitis are complications to be feared mostly, but they occur most commonly in erysipelas. Sepsis and rapid extension peripherally are the outstanding symptom complexes. Liquefaction of the cutis and subcutaneous tissues, in the processes of lymphadenitis and other deep infections of the neck which reach the surface and drain chiefly thereby, is only of local significance.

Second plane (or "space") between platysma and mylohyoid muscles: This space contains the mylohyoid nerve and blood vessels, the digastric muscle and submaxillary gland. The most common cause of infection in this area is an osteomyelitis of the mandible. A phlegmon of this space will, under rare conditions, descend into the neck anteriorly to the trachea, or more often will first reach the submaxillary gland, and then progress to the posterior border of the mylohyoid muscle, where it can travel forward into a potential space, which is to be considered next. The symptoms of an infection of this space (second plane) consist mainly of general sepsis with early swelling and redness of the skin, fluctuation and later a swelling in the region of the submaxillary gland. At times, the vallecula will be obliterated without any swelling of the mucous membrane at the floor of the mouth.

Third plane (or "space") between the mylohyoid and geniohyoid muscles: This space consists mainly of connective tissue. Its extent is limited in one direction by the attachment of the muscles and their enveloping fasciae to the body and upper border of the hyoid bone. We emphasize the fact that this fascial plane or space ends caudally and dorsally at the hyoid bone, except at the posterior border of the mylohyoid muscle where no muscle or bony walls interrupt its continuity with other fascial planes. Instead, the submaxillary gland is found here, a relation which is of great clinical significance. Since this gland is invested by and lies directly on connective tissues which are prolongations of the fascial layer of plane No. 3, suppurations can and do travel from one plane to the other. In the immediate vicinity of the submaxillary gland are to be found the lingual artery and facial vein as well as the submaxillary duct and ganglion.

The symptoms of infection of this

space are those of general sepsis and local swelling either in the submental or submaxillary regions. This swelling is usually very hard, not accompanied by redness of the skin, and extends downward to the hyoid bone. Fluctuation occurs rarely. When the infection begins in the midline, it extends later beyond the posterior border of the mylohyoid muscle to involve the submaxillary gland (periodontitis). If, on the other hand, the infection begins as a submaxillary adenitis, and then breaks through between the mylohyoid and geniohyoid muscles, the first signs of swelling to be noted are located in the submaxillary triangle. As part of this process, the mucous membrane of the floor of the mouth is moderately swelled, the vallecula becomes obliterated and the epiglottis is occasionally displaced.

Fourth plane (or "space") between the geniohyoid and the genioglossus muscles: This space is best described by dividing it into two planes, one the transverse and the other the sagittal. Further, there is a right and left transverse fascial plane, intersected by but a single sagittal fascial plane.

(a) The transverse planes lie between the geniohyoid and the genioglossus muscles and extend from the mandible to the hyoid bone. Phlegmons in its anterior portion (see b) involve both sides, whereas those in its posterior portion do not. They also involve another space, called the "paralingual space," and the region of the lesser horn of the hyoid bone. The parapharyngeal space, too, can be affected thereby, by two routes: one, by way of the submaxillary gland; the other, by way of a connective tissue space, noted by Von Thomas, which lies between the posterior border of the mylohyoid muscle and the middle constrictor muscle of the pharynx. The paralingual space merges posteriorly with a larger one, which is bounded by the hyoglossus and genioglossus muscles. It ends below at the greater horn of the hyoid bone and its attached muscles and ends above at the hyoglossus muscle fascicles as they penetrate the body of the tongue. The lingual artery traverses this space.

(b) The sagittal plane extends upward through the transverse space between the two geniohyoid muscles below and the two genioglossus muscles above. It is lost anteriorly where the two geniohyoid muscles fuse into a single body, beginning here directly cephalad between the genioglossus muscle of each side. It is evident that, anteriorly, the transverse plane is a single one: A phlegmon in this area soon involves both sides. Posteriorly, however, the sagittal plane is distinct between both geniohyoid muscles and intersects the fourth transverse plane through its middle. At the point of intersection, the connective tissue is dense and includes a number of fairly large veins, thereby creating a barrier against possible crossings here of suppurations from one side to the other. This barrier is comparable to that formed by the median raphé of the tongue, which acts in a similar manner in phlegmonous affections of this organ.

The space identified above can be the seat of a local or diffuse phlegmon, singly or collectively.

Fifth plane (or "space") between the genioglossus muscle and the mucosa of the floor of the mouth: This space contains Wharton's duct and the sublingual glands with their ducts. It may be affected directly through traumatic irritants or indirectly by way of a suppurative process involving its contents.

PHARYNGEAL SPACES

The posterior wall of the pharynx constitutes the anterior boundary of the retropharyngeal space. The layers of this wall ventrally to dorsally consist of pharyngeal mucosa, pharyngobasilar fascia and pharyngeal muscles. The potential retropharyngeal space is occupied by the loose areolar connective tissue of the

prevertebral fascia and is thickened in the median line by connective tissue fibers which bind it to the spine. The retropharyngeal space extends from the base of the skull above to the farthest point of the cervical fascia below. It may be said to extend behind the esophagus into the posterior mediastinum; laterally and above, it approximates the parapharyngeal ("pharyngomaxillary") fossa.

From eight to ten lymph nodes are found in the retropharyngeal space during infancy. These tend to disappear during the next three to eight years, so that only one or two remain on each side thereafter. Retropharyngeal abscesses are usually the result of infections of these nodes and occur unilaterally.

The pharyngomaxillary fossa is a funnel-shaped space, its base being located at the base of the skull at the jugular foramen, and its apex being just below the mandible at the level of the hyoid bone. The medial or internal boundary of the fossa is the superior pharyngeal constrictor muscle. The lateral or external wall includes chiefly the inner surface of the ascending ramus of the mandible together with its attached internal pterygoid muscle and the posterior portion of the parotid gland. The dorsal boundary consists of the prevertebral muscles. Further, the fossa is divided into two unequal compartments by the styloid process and its attached muscles. The larger anterior chamber (prestyloid) is in proximity to the tonsil; the smaller posterior chamber contains the internal carotid artery, the internal jugular vein, the vagus nerve and the cervical sympathetic ganglia and nerves. The latter compartment is separated from the retropharyngeal space by only a thin lamella of fibrous tissue, the alar fascia.

The anterior or prestyloid compartment of this fossa may become the seat of suppuration following an acute tonsillitis, acute or chronic mastoiditis (Bezold mastoiditis or petrositis), retropharyngeal lymphadenitis, parotitis, dental caries, spinal caries, pharyngeal trauma or surgery.

SYMPTOMATOLOGY

The symptoms will vary first with the anatomic location of the infection and secondly with the type of pathologic change resulting therefrom. Generally speaking, they divide themselves into groups according to whether the infection is circumscribed or diffuse and as to whether there is or is not liquefaction of the tissues. There are also symptoms associated with any of these types of pathologic processes which indicate complicating sequelae as the result of invasion of the lymphatic system. This may be in the form of either a reticular or tubular lymphangitis, and is likened to erysipelas with its characteristic picture of severe toxemia and sepsis. There may be symptoms of septicopyemia. These symptoms may be also associated with those attending an extension of the aforementioned processes into wide fascial avenues, namely, the prevertebral fascia and the carotid sheath.

Phlegmons of these fascial planes further lead to sepsis, but also to another type of symptom related to compression of the respiratory and gustatory systems at some level within the mediastinum. It is obvious that we can hardly discuss each symptom in detail, but rather should call attention to their bizarre characteristics, which may range from local discomforts alone to an overwhelming systemic as well as local symptom-complex.

The course may be mild for days and then suddenly assume an alarming character, particularly when the swelling of the parts interferes with respiration and deglutition. The temperature and pulse are often relatively increased. Extreme dyspnea requires tracheotomy even shortly after the onset. Respiratory difficulty arises because of the enormous swelling and upward displacement of the tongue. In some instances, the septic in-

toxication is of less moment as a cause of death than is the involvement of the respiratory tract. Death may occur from syncope or dyspnea, in spite of tracheotomy, artificial respiration and oxygen inhalation.

The patient is dyspneic, swallowing is painful and speech is interfered with. External edema extends over the entire neck. Edema of the epiglottis and glottis is common. A successful outcome depends on preventing the infection from breaking through its posterior barriers, reaching the carotid sheath by way of the lymphatics or descending within the neck to the mediastinum.

TREATMENT

Prophylaxis: To be emphasized in this connection is the respect of these anatomic parts by those who have to do with the instrumentation and surgical treatment of the mouth. It is essential that the lay and medical public be made aware of the importance of local and general hygiene. In so far as the dental profession is concerned, a word of warning is not amiss against the injection of local anesthetics in the presence of the hidden or manifest infections in the mouth.

Active treatment: Early in its course the treatment consists of hot irrigations of the floor of the mouth, heliotherapy and combined x-ray and short-wave therapy to the neck.

Surgical drainage of the involved area should be established before there is a break through the anatomic barriers. External incision over the point of maximum swelling and tenderness is preferable for obvious reasons. At times, it is necessary that the incision extend up through the floor of the mouth and be long enough for the introduction of soft rubber drainage tubes. The depth of the incision depends on the location of the pus and its relation to the geniohyoid muscle. This drainage into the mouth carries with it the added risk of aspiration of septic material into the lung. If pus is not immediately encountered, closed forceps are introduced and then opened in various directions. When an abscess has once been opened and adequate drainage provided, tubes should be inserted for frequent irrigations.

Care must be taken that the wound is not packed so tightly as to interfere with good drainage, which must be maintained throughout. Depending on its mechanism, dyspnea may require tracheotomy, artificial respiration and oxygen inhalation.

In the submaxillary approach, a generous T-shaped incision will thoroughly expose the submaxillary gland and allow it to be turned upward with the lingual artery out of its bed. This gives a surgical field that is most reassuring. The facial vein runs across the center of the field and must be cut between two ligatures. The hypoglossal nerve is superficial and just above the V made by the two bellies of the digastric muscle. The carotid sheath lies opposite the tip of the great horn of the hyoid bone. While searching for deeply located pus, the submaxillary gland is kept out of the way. The surgeon's finger then follows the carotid sheath upward to the base of the skull or downward, as his judgment dictates. As the finger travels upward, the surgeon first feels the end of the styloid process, and then enters the pharyngomaxillary fossa laterally to the tonsil.

If the surgeon is dealing with pus in the floor of the mouth, or at the base of the tongue, an incision in the center of the floor of the submaxillary fossa can be carried forward or backward, according to indications. The whole side of the tongue and the floor of the mouth are within easy reach.

An easier method of reaching deep-seated pus in the neck or floor of the mouth is as follows: After the patient is etherized, a small pad is placed beneath the shoulder and the face turned

to the opposite side, so that the large vessels, the submaxillary gland and other structures will be pulled away from the field of operation. An incision one and one-half inches long is then made through the skin and platysma in the neck close to the angle of the jaw. With or without blunt dissection, the finger tip is readily inserted into the buccomaxillary space to reach the base or lateral surface of the tonsil. So close is the tonsil that it can readily be pushed by a finger placed in the mouth almost to the skin surface of the wound in the neck; the base of the tongue and the mucous membrane of the floor of the mouth are just as accessible. By breaking through a very thin membrane behind and below the styloid process, the finger enters the retropharyngeal space.

In order to gain access to the vessels for their ligation or resection, the wound at the angle of the jaw has to be extended downward along the anterior border of the sternocleidomastoid muscle. In this respect, a few remarks are of importance regarding the spontaneous rupture of a false aneurism of one or more of the large arteries of the neck produced by adjacent suppurative processes and its treatment. It has been proved clinically that the greatest number of these hemorrhages attending parapharyngeal phlegmons are from the internal carotid artery. That it should be so is also apparent in the fact that the internal rather than the external carotid artery courses through the poststyloid compartment. Rupture of the external carotid or of its branches occurs less commonly and is readily diagnosed by the fact that a different region than the above is involved by the inflammatory disease.

Ligation of these branches or of the external carotid artery reflect only a feat of surgical skill! But ligation of the internal carotid artery, or, as commonly practiced, of the common carotid artery, is an entirely different matter. One has to choose in such instances between risking the possibility of hemiplegia with ligation or almost certain death without ligation. Numerous concepts have guided such procedures in an attempt to avoid cerebral damage by a sudden compression of this artery. These procedures range from one-stage ligations to those which are completed gradually, using different kinds of ligature material and instruments, over a period of hours and even days. Despite these attempts, frequent cerebral complications occur, irrespective of the procedure employed. It is known that the younger the patient, the better are the chances of recovery in the event of brain complications. Further, we know now that a most important factor is an anatomic one and is dependent upon whether or not there are adequate or anomalous arterial anastomoses at the base of the brain.

Local treatment invariably must be supplemented by general supportive measures. Convalescent streptococcus serum, sulfanilamide and blood transfusions have proved valuable and should be resorted to.

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DENTURE RUBBER: COMPOSITION, PROPERTIES AND A SPECIFICATION*

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INTRODUCTION

THE results of the research on the physical and chemical properties of denture base materials, conducted at the National Bureau of Standards in cooperation with the Research Commission of the American Dental Association have been published in several reports.[1, 2, 3, 4]

The object of these previous investigations, as well as the present one, is to obtain sufficient information to develop a standard or specification by which the dentist can select a satisfactory denture base material.

The survey made by Kimball[5] indicated that approximately 70 per cent of all full dentures were made of vulcanite. This conclusion is in substantial agreement with the opinion of others familiar with this field. The development of organic plastics, such as acrylic resins, in recent years, will undoubtedly reduce this percentage materially. However, the many desirable properties of hard rubber and its record for service will insure its use as a denture material for some time to come. Test methods which will define hard rubber (vulcanite) satisfactorily for denture use have been developed in the present investigation. Some of these methods may be used in appraising other types of denture base materials.

In order that the specification may be practical, it was necessary to limit the number of specified properties to those of importance. Many other physical and chemical properties are important; but, in order that the routine tests for compliance with the specification shall not be unnecessarily burdensome, the minimum number of tests is included which will satisfactorily define the three main types of rubber compounds used for dentures.

HISTORY

The history of the use of vulcanite or hard rubber for denture bases extends over nearly a century. Its use in dentistry followed the discovery of hard rubber by Nelson Goodyear, which was patented in 1851.

One of the first extensive uses of hard rubber was made in dentistry. This use developed so rapidly that by 1861 a journal appeared which was devoted exclusively to the subject. This journal, which appears to have been the first periodical of any kind on rubber, was entitled *The Vulcanite*, with the subtitle "A Quarterly Journal Devoted to the Science of Mechanical Dentistry." It was published by the American Hard Rubber Co., New York, for the years 1861-1862. About the same time, the composition of hard rubber for use in dentures was the subject of patent litigation‡ which engaged some of the best technical and legal talent of that day.

*A report to the Research Commission of the American Dental Association.

*Publication authorized by the Executive Board of the Research Commission.

†Research Associate of the American Dental Association at the National Bureau of Standards.

‡Henry B. Goodyear, Administrators, etc. *vs.* John Newbrough, in Equity U. S. Circuit Court, Southern Dist., N. Y. 1868-1869.

MATERIALS INVESTIGATED

The materials used in this investigation were purchased in the open market. They represent a cross-section of the types most widely used by the dentist. The brand names, together with their respective manufacturers, are listed in Table 1. These brands were not selected in preference to others; an effort was merely made to confine our endeavors to a reasonable number. To include all brands would have entailed much more work than was justified under present circumstances.

talc and hard rubber dust; but the addition of excessive amounts of these is detrimental to the mechanical properties necessary to produce a satisfactory base material. This effect is shown especially in the less satisfactory physical properties of the veneer type of rubber, where an attempt is made to improve the appearance at the sacrifice of strength.

In this report, all the chemical analyses were performed on unvulcanized samples of each brand. A partial analysis was made in which the uncorrected acetone extract, the free sulfur, the corrected acetone extract and the nonvolatile matter were determined.

TABLE 1.—MATERIALS INVESTIGATED

Trade Brand	Manufacturer	Address
Dark Elastic (olive base)	Claudius Ash Sons & Co.	Irvington, N. J.
English Base	Claudius Ash Sons & Co.	Irvington, N. J.
Gum Pink Light	Claudius Ash Sons & Co.	Irvington, N. J.
Gold Dust	Atlantic Rubber Mfg. Corp.	New York, N. Y.
All Pink Plate	Corning Rubber Co.	Brooklyn, N. Y.
Samson	Eugene Doherty Rubber Works, Inc.	Brooklyn, N. Y.
Light Colored Rubber No. 2	Eugene Doherty Rubber Works, Inc.	Brooklyn, N. Y.
Pure Para-Dark No. 27	The Hygienic Rubber Co.	Akron, Ohio
Dr. Tepper Nature Gum	Martin Rubber Co., Inc.	Long Branch, N. J.
Light Red No. 4	E. J. McCormick Rubber Co.	Passaic, N. J.
Ex. Light Pink No. 9B	E. J. McCormick Rubber Co.	Passaic, N. J.
Gould's Natural Gum Rubber Facing	The Ransom & Randolph Co.	Toledo, Ohio
Brown No. 12 Base Plate	The S. S. White Dental Mfg. Co.	Philadelphia, Pa.
Maroon No. 10 Base Plate	The S. S. White Dental Mfg. Co.	Philadelphia, Pa.
Pink Denture B No. 17	The S. S. White Dental Mfg. Co.	Philadelphia, Pa.
Veneering Rubber, Light Pink No. 3	The S. S. White Dental Mfg. Co.	Philadelphia, Pa.
Veneering Rubber, Granular Pink No. 7	The S. S. White Dental Mfg. Co.	Philadelphia, Pa.

CHEMICAL COMPOSITION

The essential elements in the production of hard rubber are caoutchouc $(C_5H_8)_x$ and sulfur (S.). The chemical reaction between these materials when properly controlled forms a relatively hard substance. Other materials, known as fillers, are added to the foregoing to improve the mechanical and esthetic properties of the vulcanized product. Some of these materials used in denture base rubber are: mercuric sulfide (vermilion) and other pigments, zinc oxide,

The procedures outlined for the determination of rubber are those described in Federal Specification ZZ-R-601, February 4, 1930, with the exception of the method of preparing the sample.

Preparation of Sample.—In order to obtain efficient extraction, the samples must be in a finely divided state. Since extraction experiments with samples cut in thin strips with scissors gave inconsistent results, another method was de-

veloped. A sheet of rubber was wrapped around a copper rod and the two were immersed in liquid air until the rubber was frozen, and the rubber was immediately filed with a coarse file. (The usual precautions about the fire hazards of liquid air should be observed.) The finely divided particles were collected on filter paper for drying and weighing, preparatory to the chemical analysis.

Acetone Extract, Uncorrected.—The acetone extract, uncorrected, consists of those materials soluble in acetone, such as natural resins, free sulfur and oils or waxes, which may be in the sample. The samples were wrapped in filter paper in order to prevent balling, and then placed in a rubber-extraction apparatus for extraction with acetone for seventy-two hours. The acetone was then distilled off and the extraction flask dried for one hour at 70° C. The residue was the acetone extract, and, from its weight, the percentage of acetone extract, uncorrected, was calculated.

TABLE 2.—CHEMICAL ANALYSES OF UNVULCANIZED DENTAL RUBBER

Denture Rubber	Density	Acetone Extract (Uncorrected)	Acetone Extract (Corrected)	Free Sulfur	Non-Volatile Residue
	Gm./Cm.³	Per Cent	Per Cent	Per Cent	Per Cent
Type A—Base					
A	1.69	21.9	5.6	16.3	32.1
B	1.43	26.3	4.9	21.4	3.7
C	1.15	32.6	4.6	28.0	8.5
D	1.62	19.8	3.2	16.6	7.2
E	1.18	33.1	6.2	26.9	9.5
F	1.41	29.8	5.6	24.2	0.3
G	1.10	28.3	4.0	24.3	6.4
N	1.93	22.9	5.5	17.4	0.3
P	1.66	22.6	6.7	15.9	1.7
Type B—All-Purpose					
H	1.77	19.2	5.8	13.4	41.0
I	1.74	16.3	5.9	10.4	54.2
Type C—Veneer					
J	2.06	13.2	5.3	7.9	44.9
K	2.39	9.8	3.4	6.4	43.2
L	2.35	8.4	2.2	6.2	37.2
M	2.19	9.3	2.5	6.8	39.4
O	2.45	8.4	2.8	5.6	34.6
Q	1.98	13.8	5.2	8.6	65.0

Free Sulfur.—The free sulfur, which is the uncombined sulfur, is removed from rubber by acetone extraction. It is determined by the following method: To the extraction flask containing the acetone extract 100 ml. of distilled water and 5 ml. of bromine were added. The flask and solution were heated in a steam bath until the solution was practically

colorless. The solution was filtered into a 250 ml. beaker and diluted to 175 ml. volume. The sulfur was precipitated as barium sulfate in the usual way by the addition of barium chloride.

Acetone Extract, Corrected.—The percentage of acetone extract, corrected, is equal to the percentage of acetone extract, uncorrected, minus the percentage of free sulfur. It is sometimes called the organic extract.

The Non-Volatile Residue.—The non-volatile residue or ash is the material left after ignition, consisting chiefly of non-volatile fillers. Ashing should be done in a hood if mercury is present in any form.

Three direct determinations were made on each brand of rubber; namely, the uncorrected acetone extract, the free sulfur and the non-volatile residue.

The results shown in Table 2 indicate that the base rubbers had the highest free sulfur content; the all-purpose, a medium content, and the veneer type, the lowest. The amount of rubber in the specimen may be assumed to be, very roughly, 2.1 times the percentage of the free sulfur to give satisfactory vulcanite when properly cured. This corresponds to a formula $(C_5H_8S)_x$ for the vulcanized rubber.

The amount of filler may be approximated by the following:

TABLE 3.—PHYSICAL PROPERTIES OF DENTURE RUBBERS*

Code Letter	Type	Unvulcanized			Vulcanized				
		Density (Room Temperature)	Plasticity Thickness of Disks		Brinell Number	Deflection Under Transverse Load			Maximum Load
			5 Minutes	30 Minutes		4000 Gm.	5500 Gm.	6500 Gm.	
	1	2	3	4	5	6	7	8	9
		Gm./Cm.³	Mm.	Mm.		Mm.	Mm.	Mm.	Gm.
A	Base	1.69	2.33	1.93	19.8	1.44	2.58	4.14	7,100
B	Base	1.43	2.18	1.90	16.8	1.67	2.74	3.98	7,500
C	Base	1.15	2.04	1.59	16.7	1.68	2.77	3.64	8,000
D	Base	1.62	2.49	2.02	16.1	1.97	4.08	....	6,000
E	Base	1.18	2.32	1.84	14.6	1.86	2.93	4.18	7,400
F	Base	1.41	1.72	1.45	16.5	1.78	2.94	4.30	7,200
G	Base	1.10	3.11	2.77	15.8	1.68	3.00	4.28	8,200
H	All purpose	1.77	2.90	2.56	21.4	1.29	2.22	3.00	7,600
I	All purpose	1.74	3.07	2.64	16.8	1.05	2.02	....	6,300
J	Veneer	2.06	2.96	2.54	19.4	1.38	3.36	4.46	6,800
K	Veneer	2.39	4.02	3.59	20.2	1.29	3.12	....	5,800
L	Veneer	2.35	3.96	3.67	12.2	....	....	....	.....
M	Veneer	2.19	4.30	3.97	13.5	3.73	....	....	4,500
N	Base	1.93	2.10	1.66	19.1	1.60	2.61	3.71	7,500
O	Veneer	2.45	4.88	4.78	....	....	....	....	.....
P	Base	1.66	2.79	2.34	....	....	....	....	.....
Q	Veneer	1.98	3.80	3.50	....	....	....	....	.....

*Values obtained by methods described in proposed specification.

$$F = 100 - (R + S + Ac)$$

F=per cent filler; R=per cent rubber; S=per cent free sulfur, and Ac=per cent "acetone extract, corrected."

The filler may include hard rubber dust. The sulfur in the hard rubber dust, in the vermilion and in other fillers is, of course, not included in the free sulfur used in the formula.

The non-volatile residue was lower for

the base rubbers than for the all-purpose or veneer types. In one case (veneer rubber Q), it was as high as 65 per cent.

PHYSICAL PROPERTIES

Unvulcanized Rubber Compound.—Success in making a satisfactory denture is dependent on the composition of the rubber compound and its physical condition when used by the dentist. The material, when received by the dentist, should be soft and pliable and not aged to the extent that it will be difficult to pack. Holland cloth can be stripped easily from properly prepared rubber without tearing or excessively stretching the rubber. Rubber stored for long periods at or above room temperature will slowly deteriorate and otherwise change its condition, depending on the temperature and humidity. Rubber in the unvulcanized state will absorb moisture if the relative humidity of the atmosphere is high. This absorbed moisture will be converted to steam in the vulcanization of the case. Care should be taken to pack the rubber soon after removing the holland cloth. The warmed rubber will pack more satisfactorily. The rubber can be warmed on a towel over a steaming water bath or preferably in a dry heater for a short time. The warm rubber, which has been previously cut to convenient sizes, should be packed so as to make a solid mass with no dirt or voids included. Any foreign material included will tend to weaken the denture or may work to the surface and be exposed on polishing after vulcanization. The case should be packed with a slight excess of stock so that pressure will be exerted on all parts of the denture on closing the flask.

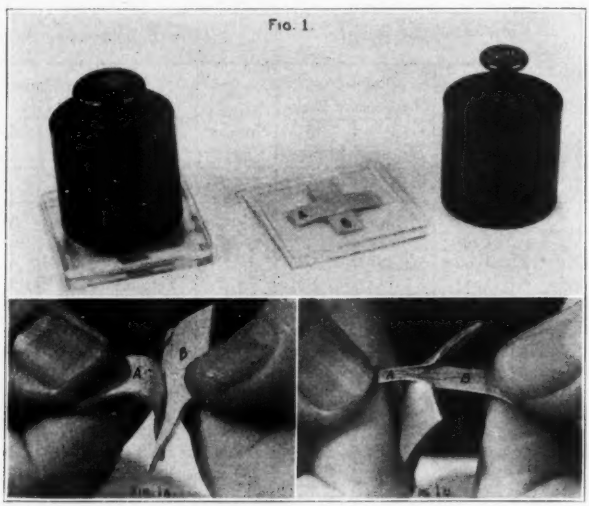

FIG. 1. PACKING TEST FOR DENTURE RUBBER.
FIG. 1a. UNSATISFACTORY COHESION. FIG. 1b. SATISFACTORY COHESION.
A & B, SPECIMENS OF DENTURE RUBBER.

Packing Test.—The packing qualities of the rubbers were investigated. Following is a brief description of the testing method which was developed. Strips were cut from the sheets of rubber after removing the holland cloth. The material and equipment were conditioned at 37°

C. One strip was placed on a glass plate, and a second strip placed across the first at right angles (Fig. 1). A glass plate and a weight, totaling 520 gm., were placed over the intersection and allowed to remain in position for five minutes. The strips were slowly pulled apart by hand. If they cohered at the intersection so that they could not be separated at their original surfaces (Fig. 1, b), the material was considered satisfactory. Most of the rubbers tested met this requirement. Old rubbers which pack unsatisfactorily will separate easily (Fig. 1, a).

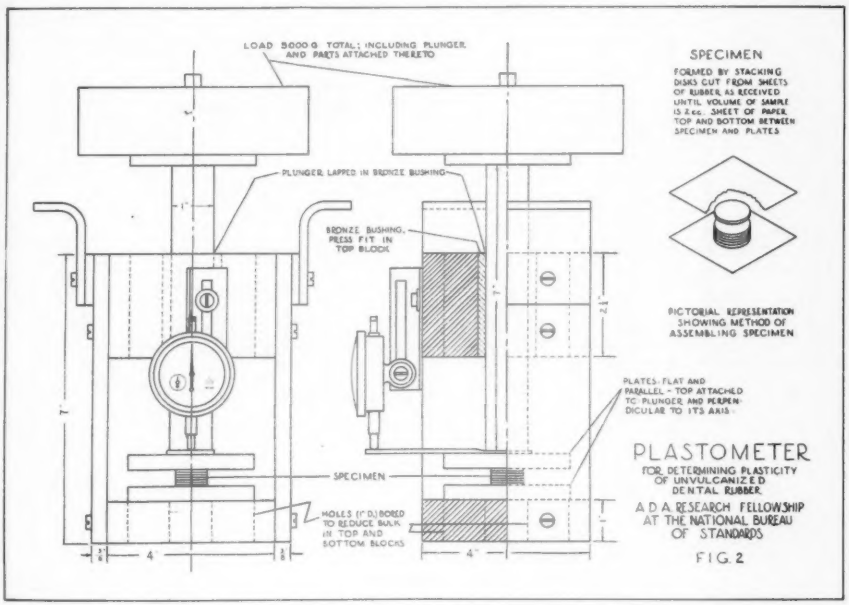
LOAD 5000 G TOTAL; INCLUDING PLUNGER AND PARTS ATTACHED THERETO
PLUNGER LAPPED IN BRONZE BUSHING
BRONZE BUSHING, PRESS FIT IN TOP BLOCK
SPECIMEN
HOLES (1" DIA) BORED TO REDUCE BULK IN TOP AND BOTTOM BLOCKS
SPECIMEN
FORMED BY STACKING DISKS CUT FROM SHEETS OF RUBBER, AS RECEIVED UNTIL VOLUME OF SAMPLE IS 2 cc. SHEET OF PAPER TOP AND BOTTOM BETWEEN SPECIMEN AND PLATES
PICTORIAL REPRESENTATION SHOWING METHOD OF ASSEMBLING SPECIMEN
PLATES FLAT AND PARALLEL - TOP ATTACHED TO PLUNGER AND PERPENDICULAR TO ITS AXIS
PLASTOMETER
FOR DETERMINING PLASTICITY OF UNVULCANIZED DENTAL RUBBER
A.D.A. RESEARCH FELLOWSHIP AT THE NATIONAL BUREAU OF STANDARDS
FIG. 2

FIG. 2 INSTRUMENT FOR DETERMINING THE PLASTICITY OF DENTURE RUBBER.

Plasticity.—The plasticity of the rubber compound is important in the construction of a denture, because it is this property that makes it possible to form the rubber into the irregular shape of the mold. The pressure necessary to close the mold is dependent on the plasticity of the rubber. Rubber, like any plastic compound, will flow when a certain stress known as the "yield value" is exceeded. The speed of closing the flask will be determined by the amount the shearing stress exceeds the "yield value." Since the pressure must be kept below that which will distort the plaster model and yet close the flask in a few minutes, an instrument was constructed on the principle of the well-known Williams[6] plastometer (Fig. 2) to measure the plasticity of the rubber. This instrument compresses a sample of the material between parallel plates. The instrument consists of two parallel plates and a means of applying a constant axial load to a 2 cc. cylindrical specimen. The height of the specimen at any given time can be measured by a sensitive dial indicator. The instrument is so constructed that it can be placed in a constant temperature oven and the dial indicator read from time to time as the specimen flows.

Preparation of Flow Specimen.—The plasticity specimen is obtained by cutting

disks from a sheet of the rubber and stacking them one on top of the other. (Fig. 2.) The volume of the test specimen is computed from the apparent density and weight of the sample. The apparent density is determined by weighing the rubber in air and in water.

The test is as follows: The equipment and instrument are placed in an oven at 70° C. The specimen to be tested is placed between two sheets of bond paper and brought to 70° C. before being placed in the instrument. The specimen is then placed in the instrument and compressed to 5 mm. in height for ten minutes. A stop 5 mm. thick is placed in the instrument. The stop is then removed and the load applied to the specimen. The time and the thickness of the specimen are recorded from the instant the stop is removed. The flow or plasticity of the specimen is determined from this information. Some results of these tests are shown in Table 3 and Figure 3.

The shape of these curves in Figure 3 shows that the specimens flow fast at first, then gradually decrease in rate of flow. In order that the testing time might simulate dental practice as nearly as feasible, limits were placed on the flow

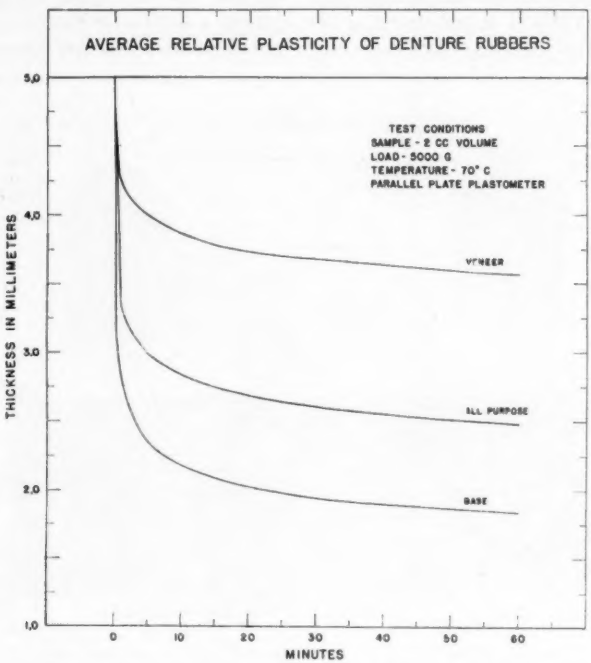

FIG. 3. FLOW PROPERTIES OF UNVULCANIZED DENTURE RUBBER.

at two time intervals; namely, five and thirty minutes. The first period measures the ease with which the material may be expected to flow when the flask is first closed. The thirty-minute interval, which is on the flat part of the curve, corresponds to the time of final closing of the flask. If veneer rubber flowed as easily as base rubber, the base rubber might displace the veneer rubber to such

an extent that when the case was polished, the base rubber would be exposed.

Density.—The apparent densities of the rubbers are shown in Table 3. The density is greatly changed by the type and amount of filler used. The apparent density varied from 1.10 to 2.45 gm./cm.^{3}, or more than 100 per cent. The densities of some of the fillers are as follows: vermilion, 8.1; zinc oxide, 5.6; whiting, 2.7. The organic pigments usually have lower densities than the inspecimen and observation of the deflection for various loads.

The specimens used were 2.5 by 10 by 65 mm. cut from a slab of the rubber which had been cured according to the manufacturer's directions. The load was applied by adding shot at the rate of 500 gm. per minute, using the instrument shown in Figure 4 for applying the load at the middle of a 50 mm. span. An initial load of 1,500 gm. was applied to the specimen. The deflections were plotted

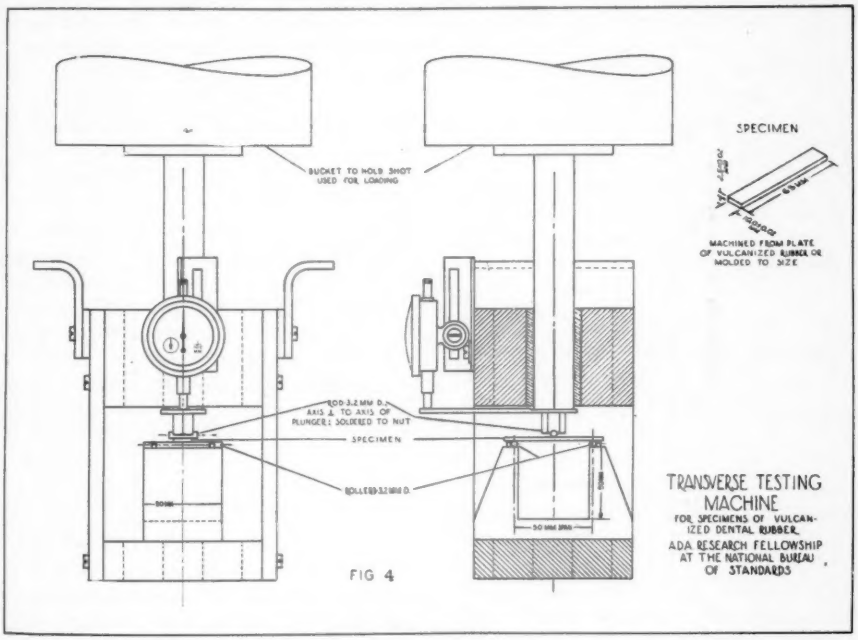
BUCKET TO HOLD SHOT USED FOR LOADING
ROD 3.2 MM D. AXIS ⊥ TO AXIS OF PLUNGER; SOLDERED TO NUT
SPECIMEN
ROLLER 3.2 MM D.
FIG 4
SPECIMEN
MACHINED FROM PLATE OF VULCANIZED RUBBER OR MOLDED TO SIZE
TRANSVERSE TESTING MACHINE
FOR SPECIMENS OF VULCANIZED DENTAL RUBBER.
ADA RESEARCH FELLOWSHIP AT THE NATIONAL BUREAU OF STANDARDS

FIG. 4. INSTRUMENT FOR DETERMINING TRANSVERSE PROPERTIES OF DENTURE RUBBER.

organic pigments. Such variations in density of the components of rubber compounds explain the differences in densities of the vulcanite denture base materials. The weight of a denture may be changed materially by the selection of a suitable combination of rubbers.

Transverse Test.—The mechanical properties of hard rubber were determined by the transverse loading of a for their corresponding loads up to the maximum load before failure. Table 3 and Figure 5 show the results of this test.

The combination of strength (load) and the deflection may be considered an index to the toughness of the specimen of rubber. The best denture material in this respect would be one which has the ability to carry a high load under transverse loading and in addition show a

large deflection before breaking. This type of material would be classified as "tough" and would absorb a considerable amount of energy before fracture.

VULCANIZATION

Vulcanization of rubber is a process of combining sulfur and rubber hydrocarbon $(C_5H_8)_x$. As the combined sulfur increases, the rigidity becomes greater. As high as 32 per cent combined sulfur may be present in vulcanite or hard rubber. The composition, and especially the accelerators present, determine the rate of vulcanization for a given temperature. The rate of combination of sulfur and rubber with increase in temperature may be called the "temperature coefficient." The increase in the "temperature coefficient" is approximately 2.0[7] fold for every 10 degrees C. rise in temperature. This shows the importance of controlling the time and temperature relationship in the vulcanization of dentures, if consistent results are to be expected.

The proper time and temperature for curing should be determined by the manufacturer for his individual products. Certain general precautions should be taken. The most important is to increase the temperature slowly up to the vulcanizing temperature. The chemical reaction between sulfur and rubber is exothermic. Energy is liberated in the form of heat. When the "run-up" time is very short, the heat of the reaction does not have time to flow out through the plaster and the temperature inside the rubber may be considerably higher than the temperature of the vulcanizer. The thicker the

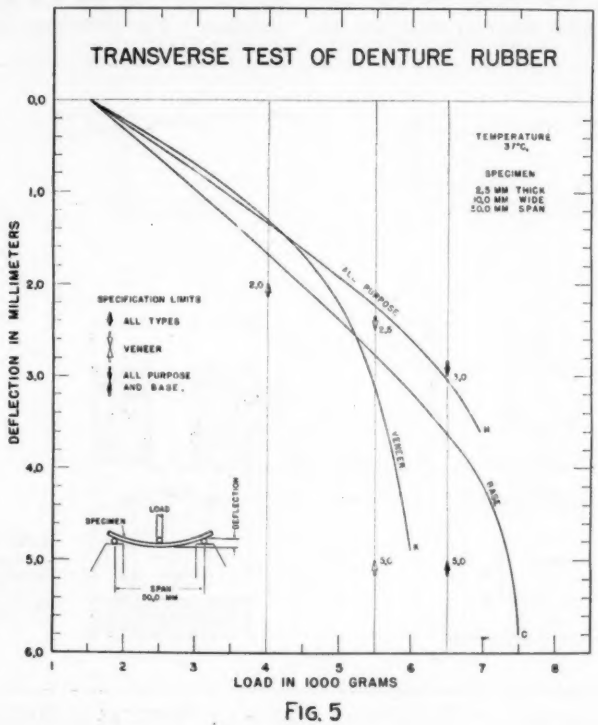

FIG. 5

case, the slower the rise in temperature should be to give best results.

Porosity in rubber dentures is frequently caused by the formation of hydrogen sulfide during the early stages of vulcanization. The requirement in the included specification that a specimen 6 mm. thick shall not show visible porosity when cured as directed by the producer forces the manufacturer to furnish instructions for a satisfactory curing rate.

Satisfactory slabs (0.25 by 3 by 6 inches) of olive base rubber were obtained by taking one hour to raise the temperature within the vulcanizer to 320° F. (160° C.) and by maintaining this temperature for two hours.

Comparison of the results of this paper with those obtained in previous investigations indicates that rubber is a satisfactory denture material, from the standpoint of mechanical and chemical properties. The limitations in appearance of hard rubber are too well known to require comment. The proposed specification for this material will be useful in selecting denture rubbers and also as a guide in the development of specifications for the more recently developed resins which are being sold for the same purposes.

SUMMARY

1. In a study of chemical and physical properties of dental significance in seventeen brands of denture rubbers, the denture rubbers were divided into three types: base, all-purpose and veneer.

2. Chemical analyses of nine base rubbers, two all-purpose rubbers and six veneer rubbers are included.

3. The unvulcanized rubbers were examined for cohesion, or packing-quality, adhesion to fabric, plasticity and density.

4. The materials were vulcanized according to the manufacturer's directions and tested for hardness and transverse strength.

5. The base type of material was in general stronger and lighter and it contained a higher percentage of free sulfur than the veneer type or the all-purpose type.

6. Methods and procedures for testing hard rubber for denture bases were developed.

7. A tentative specification for denture base rubber is recommended. This specification has definite requirements for porosity, packing qualities, plasticity and density for the unvulcanized compound as well as transverse strength and deflection for the vulcanized material.

TENTATIVE AMERICAN DENTAL ASSOCIATION SPECIFICATION NO. 10 FOR DENTURE RUBBER EFFECTIVE AS OF JULY 1, 1940

A. General Specification.

This specification is for hard rubber compound and vulcanite to be used in the construction of full and partial dentures.

B. Types.

Three types of material are specified:

B-1. Type A. Base.

B-2. Type B. All purpose.

B-3. Type C. Veneer.

C. Material.

C-1. Toxicity and Irritation.—No ingredient of the rubber compound shall, after vulcanization, be toxic or irritating to the mouth tissues.

C-2. Impurities.—The unvulcanized rubber compound shall be free from dirt, grit or other objectionable foreign materials. Coloring matter shall not be considered a foreign material.

C-3. Size.—The material shall be supplied in sheets, 7 ± 2 cm. wide, 13 ± 2 cm. long and 1.25 ± 0.75 mm. thick.

D. General Requirements.

D-1. Adhesion to Mold.—The material shall adhere to dry set dental model plaster at room temperature.

D-2. Satisfactory Working Qualities.—The rubber, when vulcanized according to instructions furnished by the man-

ufacturer, shall yield a satisfactory denture. The vulcanite shall display the following general properties:

D-2a. A smooth glossy surface when vulcanized against tin or aluminum foil.

D-2b. A smooth surface when polished according to the usual dental methods.

D-2c. A smooth unchipped surface when trimmed at room temperature.

D-3. Porosity.—Cross-sectioned vulcanized specimens (6 mm. in thickness) shall not show porosity on visual inspection.

D-4. Color.—Colors of the vulcanized rubber shall be as specified by the purchaser.

E. Detail Requirements.

E-1. Unvulcanized Compound.—The unvulcanized rubber compound shall meet the following requirements:

E-1a. Cohesion or Packing Test.—The material shall be cohesive at 37° C.

E-1b. Adhesion to Fabric.—The holland cloth shall strip easily and cleanly from the rubber compound at room temperature (25±5° C.).

E-1c. Plasticity.—The plasticity, as measured by the reduced thickness of a solid cylinder having a volume of 2 cc. shall be as indicated in Chart I.

E-1d. Density.—The density, in grams per cubic centimeter, shall be stated on the package or in the accompanying directions to an accuracy of ±5 per cent.

E-2. Vulcanized Rubber.—The vulcanized rubber shall meet the following requirements:

E-2a. Transverse Test. The deflection of specimens tested at 37° C. shall meet the following requirements indicated in Chart II.

F. Methods of Inspection and Test.

F-1. Preparation of Specimens.

F-1a. Specimens of unvulcanized rubber compound shall be made from the material as received.

F-1b. Specimens of vulcanite shall be made from materials processed in accordance with the directions accompanying the package.

F-2. Cohesion or Packing Test.—Strips 10 mm. wide and 35 mm. long shall be cut from the sheets after removal of the cloth. The strips shall be stored in air at 37.0±0.5° C. for at least thirty minutes. One strip shall be placed flat on a smooth glass plate. A second strip shall be placed across the first at right angles, a cross being formed. A glass plate (weight 20 gm.) and a 500 gm. weight shall be placed on the intersection of the strips for five minutes. The strips shall then be removed from the plates, and shall cohere at their intersection so that they cannot be separated at the original surfaces when slowly pulled apart by hand. All equipment used shall be at 37° C. before and during the testing.

F-3. Adhesion to Fabric.—The sheet shall be separated about 2 cm. at one end and shall then be torn apart by holding the fabric in one hand and the

CHART I.—PLASTICITY

Type	Thickness of Specimen (Mm.)			
	After Five Minutes Under Load		After Thirty Minutes Under Load	
	Minimum	Maximum	Minimum	Maximum
A	1.5	3.0	—	2.0
B	1.5	3.5	—	2.5
C	2.5	4.5	2.0	4.0

rubber sheet in the other, and subjecting the fabric and the rubber to a continuous pull between the hands. The maximum time allowed (after starting the ends) for the separation of one side of the sheet shall be five seconds. This test shall be conducted at room temperature (25±5° C.).

F-4. Plasticity.—The plasticity of the unvulcanized rubber compound shall be determined on a parallel plate plastometer (such as shown in Figure 2) at 70±1° C. on a specimen having a volume of 2 cc., subjected to a 5,000-gm. load, by measuring the thickness of the specimen in millimeters at various intervals of time.

The volume of the test specimen shall be computed from its weight and density. The specimen shall be prepared by cutting disks approximately 19 mm. (0.75 inch) in diameter from a sheet of the material. These disks shall be stacked to form a short cylinder, which shall be adjusted to the proper volume (2 cc.) by trimming the top disk.

The cylinder shall be mounted between two sheets of bond paper and placed in the oven containing the plastometer. Sixty minutes later, the specimen shall be placed in the instrument and compressed to 5 mm. between the plates. This shall be accomplished by placing a 5-mm. stop on the machine and subjecting the specimen to a 5,000-gm. load for ten minutes. The stop shall then be removed and the load allowed to press on the specimen. The initial time shall be taken when the stop is removed and the thickness of the specimen shall be recorded at five minutes and at thirty minutes. (Correction shall be made for the thickness of the paper.) The thickness of the specimen shall be recorded to the nearest 0.01 mm. and the average of three tests shall be reported to the nearest 0.1 mm. When the determined number falls midway between two numbers, the even number shall be reported.

F-5. Density.—The apparent density shall be determined by weighing a specimen of the unvulcanized rubber compound in air and in water at room temperature (20-25° C.). The density shall be reported in grams per cubic centimeter.

F-6. Transverse Test.—Transverse tests shall be made on specimens 2.50 mm. thick, 10.00 mm. wide and 65 mm. long at 37.0±0.5° C. The specimens may be either molded or machined to dimension. The tolerance on the thickness and the width shall be ±0.03 mm. The prepared specimen shall be stored for at least forty-eight hours at 37° C. before testing. The specimen mounted in an appropriate instrument, such as is shown in Figure 4, shall be placed over a 50-mm. span and the load applied in

CHART II.—DEFLECTION

Type	Deflection for Various Loads*				
	4000 Gm.	5500 Gm.		6500 Gm.	
	Maximum Mm.	Minimum Mm.	Maximum Mm.	Minimum Mm.	Maximum Mm.
A or B	2.0	—	—	3.0	5.0
C	2.0	2.5	5.0	—	—

*Deflection shall be measured from an initial load of 1500 gm. to load indicated.

the center of the span. The bearing surfaces shall be 3.2 mm. (0.125 inch) in diameter. The deflection shall be measured at the center of the span by means of an indicator accurate to at least 0.01 mm. An initial load of 1,500 gm. shall be placed on the specimen and the deflection read. Additional load shall be added uniformly at the rate of 500 gm. per minute until a total load of 4,000 gm. is reached. The deflection shall be read one-half minute later. The additional load as required for each type (E-2a) shall then be added at the same rate and the deflection read as before. The deflection shall be recorded to the nearest 0.01 mm. The difference between the deflections at the initial load and the total load shall be taken as the deflection of the specimen. The average of the recorded deflections for three specimens shall be reported to the nearest 0.1 mm. When the determined number falls midway between two numbers, the even number shall be recorded.

G. Packaging.

G-1. Direction for Vulcanization.—Adequate and accurate instructions for vulcanization shall accompany each package. These shall be such that they can be carried out with the equipment generally available in the laboratory of the dental practitioner. These instructions shall include the following: (a) temperature of flask when rubber is packed, (b) time to heat to 100° C., (c) time to raise from 100° C. to recommended vulcanization temperature, (d) time to hold at vulcanization temperature, (e) how to cool flask and (f) when to release pressure from flask.

G-2. Each sheet shall be placed between holland cloth.

G-3. Package Marking.—Each package of rubber shall be marked with a serial number or a combination of letters and numbers which shall refer to the manufacturer's records for that particular lot or batch.

G-4. The date (year and month) of expiration of the guarantee of compliance with this specification shall be plainly indicated as a separate item on the outside of the package.

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SELECTION AND USE OF INVESTMENTS, SPRUES, CASTING EQUIPMENT AND GOLD ALLOYS IN MAKING SMALL CASTINGS

By WILLIAM H. CRAWFORD,* D.D.S., Indianapolis, Ind.

THE discussion of cavity preparation and treatment of materials to secure the wax pattern, to which we have just listened, brings us to a consideration of the materials and methods used to change our perfect wax pattern into a cast metal duplicate. The resultant inlay, or casting, is expected to have the following features: 1. Smooth surfaces, freedom from bubbles, roughness, "lace" or irregularities which may prevent it from being seated without danger of fracturing a weak cusp or injuring a frail margin. It should also be sharp and complete in all details. 2. A size to fit snugly in the cavity and remain firmly in position, to facilitate finishing of margins, and yet be large enough to be easily and completely seated. 3. Metal providing strength, hardness and ductility sufficient to prevent permanent distortion or fracture as a result of stresses placed upon the inlay during finishing, cementation and use. 4. Soundness, by which is meant freedom from shrinkage porosity, porosity due to occluded or trapped gases or the inclusion of investment or débris.

The formation of bubbles, so called because of their resemblance to small air bubbles, is usually caused either by the trapping of a small amount of air on the wax pattern as the investment is being applied or by the application of investment in which small air bubbles have been incorporated. The trapping of air as the investment is being applied is usually due to carelessness, but may quite easily occur in certain instances unless precautions are taken. It is difficult to paint investment well into proximo-incisal angles of three-quarter crowns and patterns of preparations where a cusp has been shod. Care should be exercised in joining two separate portions of investment on the inner surface of the pattern. There is less danger of trapping air if the painting of the pattern is spread from one point until the entire inner surface is covered. These so-called bubbles are usually attached and easily removed, offering no serious hazard if discovered; but if they are not seen, they may easily break enamel rods or even be the cause of a broken cusp. It is my belief that investment and water should always be incorporated with a mechanical spatulator, as this usually eliminates the possibility of painting the pattern with investment which has large air bubbles in it.

Roughness of the surface of the casting may have a number of causes, but usually is the result of carelessness. An unclean sprue base to which investment has clung will cause roughness of the surface of the investment, from which small pieces of plaster or investment can easily be detached. If air pressure is used in casting,

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the alloy is melted on this surface. It should therefore be a hard smooth surface in order to prevent incorporation of pieces of plaster into the molten metal. If the centrifugal method of casting is used, the danger is just as great because the molten metal strikes and washes across the investment with considerable force. A hard smooth, almost glazed surface can easily be secured simply by keeping the sprue base clean and thinly oiled. Unless precautions are taken, flakes of investment may easily be washed into the sprue with the metal and may lodge at some vital spot. The sprue should always be heated and can be removed with

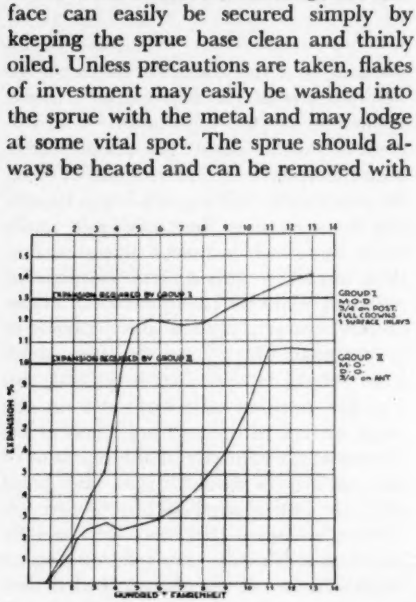


Fig. 1.—Graph showing expansion required by two groups of small castings.

a twisting motion in order not to loosen or crack the investment.

Many modern investments are strong enough to withstand heating at a rapid rate, but heating slowly enough to prevent violent boiling and the formation of steam will help to hold the inner investment walls intact and prevent breaking away of chips of investment. These small flakes of investment remain in the mold, and inrushing molten alloy will frequently wash them down to a gingival or some other margin and a worthless casting will be the result.

"Lace," as I have chosen to call it, sometimes occurs on the inner surface of castings, chiefly when cristobalite investment has been used. It appears as a very thin shelflike projection of metal, frequently seen on full or three-quarter crown castings near the gingival margins, or may be seen on inlay castings on sharp line angles. Lace results when gold is cast into cracks in the investments. Figure 1 shows the thermal expansion reaction of two commercial investments, and it will be noted that the one with the greater expansion expands most between 300 and 500° F. This is typical of an investment which uses cristobalite silica for the expanding element. When an invested pattern is placed in a hot furnace, the outer portion of the investment is heated

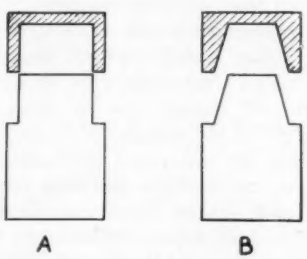


Fig. 2.—Schematic drawing showing cause for variation in friction in different cavity preparation.

rapidly. Because investment is a poor conductor of heat, the inner portion is heated much more slowly. One can readily see why investment might easily develop fissures, if the center of the ring were 300° F. and the outer portion were 200 degrees higher. There would exist fully 1 per cent variation in expansion. It is my feeling that many more such cracks occur in cristobalite investment than show up on the castings, because the cracks gradually close as the inner portion reaches the same temperature and the metal ring helps to hold the investment intact. Without a metal ring,

it is, I have found, difficult to heat a mass of cristobalite investment without having it crack badly.

With regard to obtaining a casting sharp and complete in all details, failure to heat the alloy well above the upper limit of the melting range and to keep the metal well fluxed and free from oxides is, I believe, the most frequent cause of failure. Frequently, when margins are rounded and shiny, the wax has not been completely eliminated. More will be said later in regard to heating the metal.

The second requirement has to do with the size of the casting. When William Taggart[1] introduced dental castings in 1907, the amount that gold alloys contracted in the dental mold was not known or even given intelligent consideration. Consequently, no attempts were made to compensate for gold contraction, and the investment simply served to produce a mold, into which the gold alloy was cast, accurate reproduction of size being disregarded.

Fig. 3.—Long parallel walled preparations affording much frictional retention.

Fig. 4.—Short tapering preparation affording only slight frictional retention.

Price[2] and Van Horn,[3] in 1911, both pointed to the contraction of gold and its effect on the size of the casting. It was thought, at that time, that gold contraction was 1.6 per cent. That the profession gave no serious thought to the findings of these workers is shown by technics commonly practiced as late as 1923 to 1925. Kerr's combination and Knapp's No. 1 investments were very popular at that time, and it was common practice to heat the investment to drive off wax and water, allow the investment to cool to room temperature and then cast. This treatment would usually produce a casting from 2 to 3 per cent smaller than the wax pattern, as the cooling of the high plaster content investment caused it to contract considerably and added to that was the contraction of the alloy.

In 1922,[4] the problem of dental materials was attacked at the National Bureau of Standards in a cooperative program with the Weinstein Research Laboratories. Casting of inlays was one of the first problems, and I am frequently reminded of a statement made by Wilmer

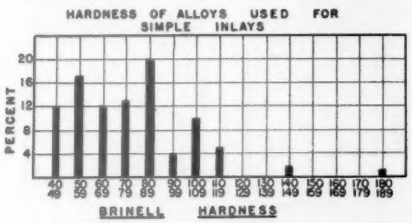


Fig. 5.—Graph showing hardness of alloys used by dentists for simple inlays. A wide range is found suitable.

Souder[5] at about that time: "If there is another problem in dentistry concerning which one can read more and learn less, articulators excepted, I have failed to find it." Empiricism soon vanished, however, with the advances made in research in this subject. R. L. Coleman[4] reported the contraction of gold as 1.25 per cent. Following this finding, many technics were advocated which attempted to compensate accurately for the contraction of gold, and most of which employed some system of wax expansion. These technics were all "tricky" and frequently produced warped rather than expanded patterns, as was shown by Maves[6] and others. Wax expansion was necessary, however, as no investment existed which alone ex-

panded enough to balance the 1.25 per cent contraction of gold.

If wax expansion methods had proved satisfactory, the frantic efforts of the profession to produce well-fitting castings would have ended there. Owing to dissatisfaction with wax expansion methods, efforts were continued to improve castings, and today investments can be made which will more than compensate for gold contraction. The question which naturally arose was "What is the correct expansion to compensate for gold contraction, and is it the same for all castings?"

As long ago as 1932, at Columbia, we established the desired investment expansion at 1 to 1.1 per cent for certain types of castings with small retention and short converging cavity walls, and at

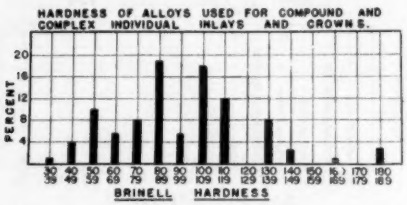


Fig. 6.—Graph showing hardness of alloys used by dentists for complex individual inlays and crowns.

1.3 to 1.4 per cent for another group of castings which had much retention with long parallel walls, as in Figure 1. Phillips,[7] in 1935, pointed to the requirement of a variation in investment expansion to suit the different cavity preparations. As a result of his findings, the control system was devised which today serves very satisfactorily.

The requirement of various expansion levels of investment to suit different cavity preparations is sound, I believe, because it has proved itself in many practical ways. Let me explain how this was accomplished at Columbia University. A unique situation existed at Columbia, where a group of skilful and experienced operators employed by Columbia practiced restorative dentistry for the employes. We also had a well-equipped physical laboratory for testing all dental materials. For more than a year, all castings for the teaching clinic were made in the physical laboratory. Frequently, several castings, varying slightly in size from the use of different expanding investments, were made for the same cavity. Careful records were kept showing the setting and thermal expansion of the investment used, with all other information which might be considered pertinent. Investments varying in expansion from 0.8 to 2 per cent were used. It soon developed that our operators were best satisfied with two expansion levels, depending on the shape and retention of the area of preparation.

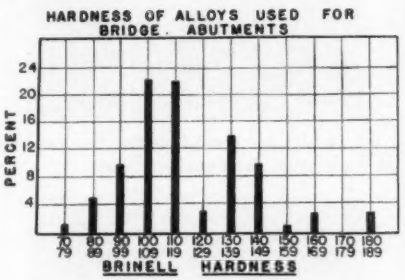


Fig. 7.—Graph showing hardness of alloys used for bridge abutments.

Figure 2 explains why some castings seem to fit more snugly than others with the same amount of compensation for gold contraction. Figure 2, A represents a cavity or crown preparation with parallel axial walls. As the casting is placed in position, it contacts the cavity walls long before it is completely seated, and friction increases as the casting advances. Any slight irregularity will easily prevent the casting from being seated, and it is seated and removed with difficulty owing to the great friction. The irregularity of cavity walls and of cast surfaces must also be kept in mind as in both it determines the ease with which castings can be seated. In Figure 2, B,

seating would not produce any friction because the inlay would not touch the tapering cavity walls until it was fully seated.

Figure 3 shows some amalgam models of practical preparations, illustrating similar conditions to those presented in Figure 2, A. These preparations have longer and more nearly parallel walls, requiring more expansion to facilitate seating, and for these cases I would recommend cristobalite investment. The preparations shown in Figure 4 illustrate conditions similar to those shown in Figure 2, B. They require less expansion than those illustrated in Figure 3. I would recommend 1 to 1.1 per cent thermal expansion.

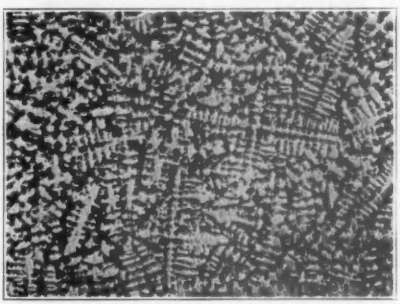


Fig. 8.—Photomicrograph of gold alloy commonly used for small castings, showing dendritic structure. The light areas indicate the metal freezing out in the upper limit of the melting range and the dark areas indicate the portions which freeze out last or in the lower end of the melting range. (×100.)

The major problems of producing well fitting castings have, I believe, been solved. It remains now to make minor refinements, and for the individual to perfect his technic.

Much could be said in regard to the physical property requirements of the metals used for inlays and small castings, most of which would be largely empiric because, as far as I know, no scientific investigation has been made to determine the actual physical property requirements of metals used in various types of small castings.

Two surveys have been made in the form of questionnaires to large groups of dentists. The first was made by Dr. Souder,[8] results being used in establishing the present specification for casting gold alloys. The second I made, with the assistance of the First District Dental Society of New York. The procedure used in both was to request the name of the alloy found to be satisfactory for a given type of preparation.

When the name of the alloy found satisfactory for various types of preparations was known, it became an easy matter to determine what physical properties had been found to be satisfactory, since the physical properties of the various alloys had been established.

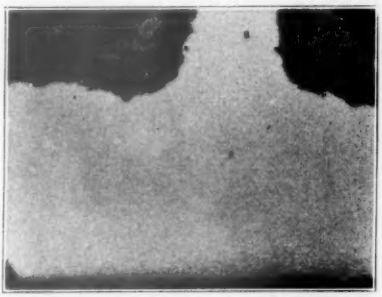


Fig. 9.—Cross-section of inlay at base of sprue, showing dense porous-free casting (bulky short sprue).

The properties which are most significant in selecting an alloy suitable for small restorations are proportional limit, hardness, ductility and melting range. Of these, perhaps the most important is proportional limit, because it gives a measure of the strength of the alloy. In other words, it indicates the relative resistance of an alloy to permanent deformation. Under masticating force, a filling is subject to stresses which may actually produce a permanent change in its shape. The proportional limit also indicates the relative ease with which a filling can be

burnished or finished to produce a smooth margin. An alloy with low proportional limit is more apt to assure smooth, well-finished margins than an alloy with a high proportional limit, because the alloy with the high proportional limit cannot be burnished to the margin easily.

In the evaluation of dental gold alloys and their physical properties, the hardness, usually indicated as Brinell hardness, has been used more than, and very largely in the place of, proportional limit. There is a certain amount of justification for this because hardness numbers increase somewhat in proportion to an increase in proportional limit, so that an alloy which has a high Brinell hardness will usually have a correspondingly high proportional limit. It may be easier for us to think in terms of hardness than proportional limit. Either property may be used, however, in the selection of alloys when we are interested in a variation in physical properties; and certainly, within the limits of practical application, we may be assured of securing an alloy with a higher proportional limit when we select an alloy with a higher hardness, and vice versa.

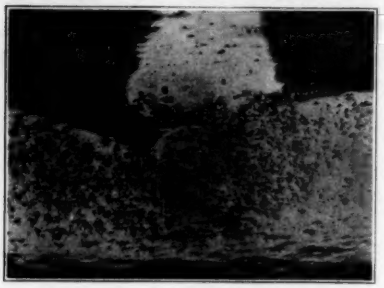


Fig. 10.—Cross-section of inlay at base of long thin sprue.

The ductility of these alloys, which is usually indicated by percentage of elongation, is an indication of how much an alloy can be burnished or bent without danger of breakage or fracture. It becomes significant to the operative dentist as an indication of the amount of burnishing and finishing that he may expect to do at the margins without danger of breaking off small pieces of the filling.

There is slight danger of difficulty arising from lack of ductility in alloys with Brinell numbers up to 120, provided sound castings have been secured. Most alloys in this hardness range are very ductile; and even in alloy with hardness numbers up to 140, little trouble is to be expected from lack of ductility. However, it must be remembered that most alloys which have a Brinell number of over 120 are quite susceptible to hardening by slow cooling or holding at temperatures between 480 and 840° F. It must be remembered that as strength and hardness increase, ductility decreases. When the hardness of alloys has been increased to 160 (Brinell) or more, there is considerable danger of brittleness in the alloy.

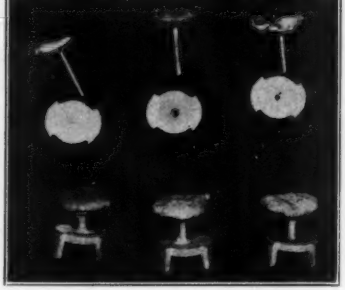


Fig. 11.—Six consecutive castings made with two different types of sprues. Castings made with short bulky sprues are dense and well-attached, but castings made with the long thin sprue are poorly attached, as in Figure 10.

The survey that I conducted indicated that alloys with a wide variety of physical properties are used with considerable satisfaction for simple restorations, as shown in Figure 5. This is not surprising since strength requirements for simple restorations are not particularly significant, as most of the simple inlays are

relatively bulky and not subject to especially high stresses. It will be noted that the highest percentage of dentists in this survey used alloys which had a hardness number between 80 and 90, but that there were operators in almost equal numbers who preferred alloys with a Brinell hardness number of about 50. Where strength is not significant, the wise operator will select an alloy with a relatively low Brinell hardness number or proportional limit in order that satisfactory finishing of the margins may be facilitated.

Response to the question regarding the choice of alloys for compound and complex individual inlays and crowns (Fig. 6) indicates a trend toward higher Brinell hardness with a corresponding increase in proportional limit. This indicates that many operators have observed, as the restoration becomes more complicated, a necessity to increase the strength in order to prevent permanent distortion.

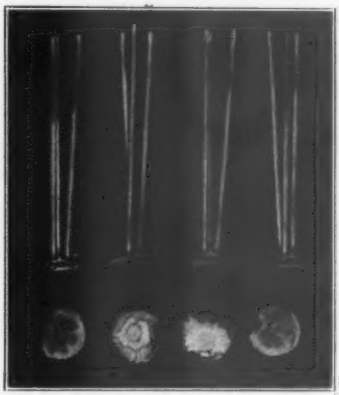


Fig. 12.—Four castings producing twelve test rods made in air pressure casting machine.

In response to the question regarding the preference of alloys for bridge abutments, no operators indicated that they were using alloys with a Brinell hardness below 70, and by far the majority were using alloys of a Brinell hardness between 100 and 120, as indicated in Figure 7.

This finding, I think, is significant, since the strength requirement of bridge abutments is certainly considerably higher than the strength requirements for individual restorations. The fact that many dentists are using alloys of relatively high strength and hardness is indicated by the comparatively high percentage of dentists using alloys with a Brinell hardness of 130 to 140. Alloys with a Brinell hardness above 120 usually harden considerably on slow cooling.

No discussion of the selection of alloy would be complete unless the matter of tarnish and discoloration of alloys was considered. At present, we do not have a standardized method for testing alloys for resistance to discoloration and tarnish.[9] As resistance to discoloration will vary, depending upon the chemical composition of the alloy, freedom from porosity in the casting and degree of polish, all factors must be considered. Rough unpolished areas will collect débris and discolor much more rapidly than highly polished surfaces, and it is therefore desirable to obtain the highest polish pos-

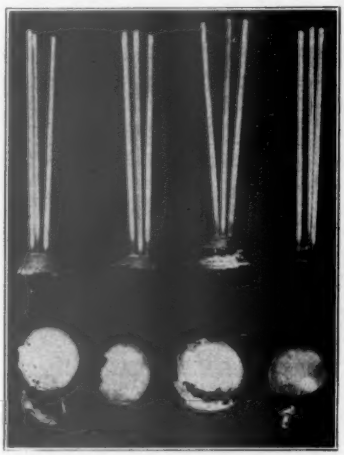


Fig. 13.—Four castings producing twelve test rods made in centrifugal casting machine.

sible, to help prevent discoloration. The rôle of chemical composition and its effect on the resistance to discoloration are not clearly understood, and until more information is available, I would suggest the selection of alloys which conform to the American Dental Association specifications for chemical composition.

The fourth requirement has to do with producing sound castings; in other words, castings that are free from porosity. Porosity may appear in castings in at least three different forms; first, as the result of contraction of molten metal during the freezing or solidifying process. This type of porosity, which is impossible to prevent, may be controlled very largely by careful selection of the sizes of sprues used and by proper placing of the sprues. The second type of porosity is a result of the trapping of air or occluded gases. The third type is the result of inclusion of investment, oxides or other débris.

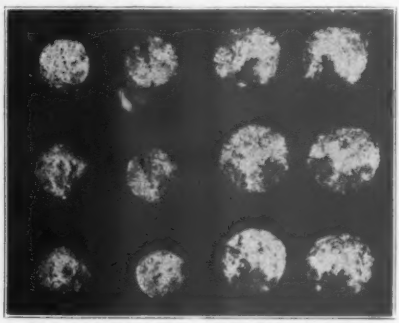
It may be well at this time to explain the process of solidification in dental gold alloys, as the control of shrinkage porosity depends on our knowledge of this phenomenon. Alloys used in dental castings are usually of the solid solution type, which means that all metals in the alloys are completely soluble in each other and that the alloys, instead of having a melting point, have a melting range. It is not uncommon for dental alloys to have a melting range of 100 to 150° F. This means that when the molten metal is cast into the mold, it may begin to freeze at approximately 1800° F. and not be completely frozen until the temperature has dropped to 1650° F. Metals of this type usually freeze to form a typical pattern. Starting at many centers, the metal will begin to freeze at the upper end of its melting range. As the temperature continues to fall, the metal adds to the centers originally formed to produce what are called dendrites. As the temperature continues to fall, these spinelike forms continue to grow until they are arrested by collision with adjacent dendrites. After growth of the dendrite is arrested, the remaining molten metal fills in around the originally formed dendrite. Figure 8 shows a section of a dental gold alloy with a typical dendritic formation. The light areas indicate the metals first to freeze, the dark areas indicate the metals that froze in the lower portion of the melting range. The typical pine cone or fernlike structure is clearly seen.

During freezing, the motion of the molecules of the metal is considerably reduced, and hence, in the frozen metal, they are not so widely separated; which means that the metal in a molten condition will occupy more space than it will when frozen. During the early part of the freezing process, the framework of the metal is established by the formation

TABLE 1.—PHYSICAL PROPERTIES OF CASTINGS MADE BY AIR PRESSURE AND CENTRIFUGAL METHODS

Castings Tested	Times Metal was Melted	Method of Casting	Elongation %			Ultimate Tensile Strength lbs/sq in		
			Aver	High	Low	Average	High	Low
4x12	Second	Air Pres	26	30	20	60,400	61,500	58,100
4x12	Third	Cent	16	26	0	54,200	59,700	36,100
4x12	Fourth	Air Pres	24	28	21	59,500	61 400	57 200
4x12	Fifth	Cent	15	24	0	50,500	58,300	29 200
4x12	Sixth	Air Pres	23	25	20	57,750	59,700	56,200
4x12	Seventh	Cent	15	24	6	51,300	56,400	43,500
Average for Air Pres			24			59,200		
Average for Cent			15			52,000		

of the spines of the dendrites, and, as freezing continues, with an accompanying contraction, there is, at the end of the freezing process, an insufficient amount of metal to fill in completely around the originally formed framework. This results in voids around the spines of the dendrites in the portion of the casting where freezing occurs last. The portions that freeze first have sufficient metal to fill in around the dendrites as it is being supplied by molten metal from portions of the casting to freeze last. Thin portions are usually free from shrinkage porosity, but thick bulky portions are frequently porous. If the sprue is attached to the bulky portion of the casting and is of proper size, length and design, it should



A B

Fig. 14.—A, fractures of three rods from Figure 12. The clean surface and reduction in diameter as compared to b are to be noted. All rods were of the same diameter before the tensile test. B, fractures of three rods with properties shown in Table 3. Porous areas, shown in dark portions, caused early rupture, resulting in low ductility and strength.

provide for continuous flow of metal into the last portion of the casting to freeze.

In casting an inlay, the metal is forced from the molten button through the sprue and into the inlay mold. Freezing will occur most rapidly in the thin portions of the casting; in other words, where there is a small amount of metal in contact with a comparatively large area of investment. The operator should adjust the spruing and investing of the pattern to insure the freezing of the inlay before the sprue and button have frozen. A continuous flow of metal in the lower portion of the melting range can thus be expected to be drawn into the freezing inlay. In case a long thin sprue is used, the metal will freeze in the sprue before it freezes in the inlay and thus prevent further metal from entering the inlay mold. This disparity in cooling can be avoided by using a short bulky sprue or by placing a reservoir larger than the adjacent portion of the inlay into which the sprue is inserted.

I have heard clinicians recommend the use of reservoirs on the sprue which were somewhat smaller than the portion of the pattern into which the sprue was inserted, a procedure that would completely defeat the purpose of the reservoir. The reservoir, being somewhat smaller than the adjacent portion of the casting, would freeze first and draw metal from the casting to the reservoir, and thus the casting would become more porous than if the reservoir were not used at all.

Figure 9 is an unetched cross-section of an inlay through the base of the sprue. The casting is perfectly dense and free from shrinkage porosity, as in this case a short bulky sprue was used. Figure 10 is a cross-section of an inlay through the base of a sprue which was long and thin. The irregular porosity surrounding the base of the sprue, which is the result of shrinkage, is negatively dendritic in form, thus indicating that there was an insufficient amount of metal available at the lower end of the melting range to fill in around the dendrites. In this case, the long thin sprue froze early, and further metal was prevented from entering the casting as freezing was taking place. Figure 11 shows six consecutive castings. The first three were made with a short bulky sprue and would, if sectioned, show dense structure, as indicated in Figure 9.

The last three castings are completely detached where the sprues enter the castings, thus indicating that the shrinkage in this area was so great that no bond was maintained between casting and sprue. This has occurred to every one who has made many castings and is simply due to the fact that the sprue was completely frozen before the metal at the point of attachment was frozen.

Another type of porosity commonly found in dental castings is due to occluded gas. During the melting process, the molten metal, if not well protected, will be exposed to air and end-products of the combustion of gas and air or whatever combination of gases is used in the flame employed to melt the metal. Certain metals used in making the alloys are very susceptible to gas occlusion. Silver, for example, which is used in small proportions in practically all gold alloys and in very high proportions in the newer white alloys used as gold substitutes, will dissolve oxygen in very high proportions. As the metal freezes and the temperature falls, the oxygen is no longer so soluble in silver and is precipitated out. Palladium will dissolve high proportions of hydrogen. Copper is also susceptible to oxygen occlusion. Both palladium and copper are used in very high proportions in the newer inexpensive gold alloys. This combination, together with a high silver proportion, produces alloys which must be handled with great care during melting in order to produce castings free from the type of porosity due to occluded gas. This type of porosity, which appears in dental castings as round regular voids, will be evenly distributed throughout the entire casting.

In order to learn how to improve the density of castings, I have conducted experiments using various methods for melting the alloy and various types of casting machines. Ductility and ultimate tensile strength are the physical properties most affected by lack of density in castings, the more sensitive of these two being ductility. In testing alloys to determine ductility and ultimate tensile strength, the metal is cast into rods sufficiently long and of uniform diameter so that they may be loaded in tension until they have been broken. If the metal is sound and ductile, it will stretch out considerably in the tensile test, the amount that it will stretch or elongate being known as the percentage of elongation. This test is used to reveal any type of porosity that may exist in the cast rod. If porosity exists in the rod at any place,

TABLE 2.—EFFECTS ON ELONGATION AND ULTIMATE TENSILE STRENGTH WHEN DIFFERENT NUMBERS OF RODS ARE CAST AT THE SAME TIME

Castings Tested	Elongation Per Cent	Ultimate Tensile Strength Lbs./In.²
1 x 3	28	62,500
	29	64,500
	28	64,500
1 x 3	28	65,200
	33	66,000
	33	64,500
1 x 2	33	64,500
	33	64,500
1 x 1	32	64,700
1 x 1	20	64,600
1 x 1	32	64,300
1 x 1	30	64,800
1 x 1	32.5	64,400
1 x 1	27.5	63,200

TABLE 3.—EFFECT OF LENGTH OF CAST ROD ON STRENGTH AND DUCTILITY*

Elongation Per Cent	Ultimate Tensile Strength Lbs./In.²
8	50,800
16.5	57,800
8	50,500
30	64,600
30	64,800
9	50,800

*Castings tested 1 x 1.

*Compare with properties of specimens in Table 2, which were 3 inches long.

the cross-sectional area at that point is considerably reduced, and the metal will break at that point long before it has had an opportunity to elongate or be subjected to a high load, consequently producing a low elongation and a low ultimate tensile strength figure.

The remaining portion of this paper will deal with various problems having to do with factors in the development of sound castings in test specimens. A series of tests was made with the following objectives: to ascertain, if possible, whether any constant difference exists between cast rods made in the air pressure type of machine and those made with the centrifugal machine, and, at the same time, to ascertain whether any material loss in strength occurred owing to casting and recasting of the same metal a number of times.

Figure 12 shows four castings made in the air pressure machine, which produced twelve specimens. Figure 13 shows four castings of the same metal made in a centrifugal machine. All rods were smooth and free from bubbles and adhesions, and appeared identical on the surface. Table 1 indicates the elongation and ultimate tensile strength of a series of these castings. The first line of physical properties, which represents the average of twelve rods secured by casting the metal in an air-pressure machine, shows an average elongation of 26 per cent, with the highest elongation 30 and the lowest 20. The third time the same metal was melted, it was cast into twelve rods with a centrifugal machine. Here, we find the average elongation was 16 per cent, with a high of 26 and a low of 0. The same metal was again recast, this time by air pressure, and the average elongation increased to 24 per cent, with a high of 28 and a low of 21. The fifth time that the metal was remelted and cast by the centrifugal method, it showed an average elongation of 15 per cent, with a high of 24 and a low of 0. The sixth time that the metal was remelted, it was cast by the air pressure method, the average elongation coming back to 23 per cent with a high of 25 and a low of 20. The seventh time that the metal was remelted, it was cast by the centrifugal method, the average elongation again being down to 15 per cent with a high of 24 and a low of 6. The total average of elongation for the air pressure method was 24 per cent, the average elongation for the centrifugal method, 15. This table indicates that the metal cast by the air-pressure method gave consistently higher and more nearly uniform results as far as ductility was concerned, which is the most sensitive test for sound castings. It also indicates that metal may be remelted many times, and if it is properly fluxed and treated, there will be little if any loss in valuable physical properties.

The alloy used in this test had the following formula: gold, 79 per cent; silver, 7; palladium, 2.5; platinum, 3; copper, 7.5, and zinc, 1.

This series of experiments was repeated with this alloy as well as with other alloys, and the same general picture was obtained.

With the idea that possibly casting more than one rod at a time might influence the density of the castings, experiments were conducted with the same alloy, in some cases casting three rods at one time and in others casting one and two rods at a time. Table 2 gives the typical result of one of these experiments.

An examination of the elongation and ultimate tensile strength of rods made in numbers up to three in one casting indicates that there is no significant difference in the physical properties of any of the rods.

Further experiments were conducted to determine the effect on the length of the cast rod as to strength and ductility. Table 3 presents the typical effect obtained by casting rods 6 inches long.

It will be noted that there is considerably greater variation in the strength and

ductility of the 6-inch rods than is noted in the case of the rods referred to in Table 2, which were 3 inches in length. My experience has indicated that I can consistently cast rods 3 inches in length without the danger of obtaining castings that are not dense owing to shrinkage porosity. However, in rods of more than approximately 3 inches in length, I have noted considerable likelihood of shrinkage porosity in the cast rod. The 3-inch rod is long enough to be used satisfactorily for a test specimen.

Figure 14 illustrates the fracture of six cast rods. The three fractures shown in Figure 14, A were selected from three specimens from Figure 12. The fractures in Figure 14, B were taken from cast rods 6 inches in length. The dark areas in these fractures indicate portions where there was a considerable amount of shrinkage porosity. The diameter of all of the rods in the figure was originally the same. The difference in the diameter as illustrated indicates the amount that the rod has been reduced owing to the stretching process. Because of porosity of the three rods at the right, there was considerable loss of ductility and strength.

Tests were also conducted to indicate any variation in physical properties that might be expected from using different types of blowtorches and different methods of melting gold alloys. The various methods of melting the gold alloys tested were (1) the blowtorch; (2) melting of the metal in alundum crucibles over globar heating elements, and (3) melting in a platinum wound resistance furnace. In no instance was I able to secure physical properties which were as good as I was able to obtain by using the gas and air blowpipe and the air pressure casting machine. Attempts to improve the physical properties of the cast rods by melting the alloy in the controlled atmospheres of hydrogen, nitrogen, illuminating gas and air indicated that there was little difference between nitrogen, illuminating gas and air, but that hydrogen was definitely detrimental and produced very poor and porous castings. No increase in ductility or strength resulted from melting the alloy in a platinum wound muffle at a number of different temperatures. As a matter of fact, physical properties were actually reduced in degree.

The results of my experiments indicate that the gas and air blowpipe is a very satisfactory means of melting gold alloy, provided the blowpipe is carefully adjusted and the alloy being melted is kept in the reducing portion of the flame, which is just beyond the green inner cone. The metal should at all times be well covered with a reducing flux. The flux used in the preceding experiments was one-third boric acid, one-third borax glass and one-third powdered charcoal.

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GALVANISM IN THE ORAL CAVITY*

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THE existence of galvanic currents in the oral cavity has been a matter of discussion for nearly eighty years. A report by E. S. Lain[1] in 1932 revived the controversy, and since then an increasing number of papers on the subject have been published. Lain,[2] Solomon,[3] Reinhard[4] and their co-workers have done extensive research in this field and their findings and conclusions have impelled us to publish the results of our experiments.

This paper deals solely with the question as to whether galvanic currents can be generated by two or more dissimilar metals in the oral cavity. In further limitation, only those phenomena have been considered wherein the presence of measurable galvanic currents was assumed by previous authors. The problem of corrosion of one metal or one alloy through electrolytic action has not been considered.

From the electrochemical point of view, three different combinations of dissimilar metals can occur in the mouth: (1) dissimilar metals which never come in contact; (2) dissimilar metals which are always in contact, and (3) dissimilar metals which are intermittently in contact in mastication.[5]

1. A metal placed in an electrolyte, such as saliva, assumes an electric potential, which depends mainly on the nature of the metal. Two dissimilar separate metals will therefore show a difference of potential. The EMF (electromotive force=difference of potential) between two dissimilar metals in the oral cavity has been measured by previous authors[2, 3, 4] and the value of the EMF of different combinations of dissimilar metals was found in agreement with the "electromotive force series." This led to the conclusion that galvanic currents were generated by this difference of potential. However, in order to obtain a flow of current, it was necessary to connect the sources of potential difference by a metallic conductor. This had to be done, of course, during the measurement of potential difference or during other experiments in which the two metals were connected by copper wires, through galvanometers and other electrical instruments, and, though the reported potential differences undoubtedly exist, galvanic current was flowing only during the time of measurement.

In order to show that potential differences exist between metal fixtures outside the oral cavity, we measured the potential differences between rings, wrist watches, glasses frames and other metallic objects which were in contact with the skin. These potential differences were of the same order as those found between dissimilar metals in the oral cavity.

2. If two dissimilar metals in the oral cavity are in direct contact, the necessary condition for the generation of galvanic current is fulfilled. A current reading can be obtained if a gold wire and a platinum wire are placed in an electrolyte and connected through a galvanometer (which establishes direct contact).

*From the Foundation for Dental Research of the Chicago College of Dental Surgery.

Read before the Section on Therapeutics, Pathology and Research at the Seventy-Sixth Annual Midwinter Meeting of the Chicago Dental Society, February 14, 1940.

However, after a short time, current intensity decreases and, after two hours, the galvanometer needle approaches its zero position. This phenomenon, called polarization, may be explained in two different ways. Ohm's law, $i=e/r$, shows that a decrease of current intensity (i) may be caused by either a decrease of potential difference (e) or by an increase of resistance (r). In the first instance, it may be assumed that a counter electromotive force (polarization potential) decreases e and therefore also decreases current intensity (i). In the second instance, it can be assumed that the surface of the electrodes is altered by the flow of current in such a way as to increase the resistance of the system (r) and therefore to decrease current intensity (i).

Our present knowledge of the phenomenon of polarization makes it possible to foretell the rapid decrease of current intensity in the experiment with the gold and platinum wires; but the effect of polarization cannot be calculated quantitatively, because the system in which current is actually flowing is said to be irreversible, and thermodynamics does not permit a calculation of potential differences or current intensities of such systems. The question as to whether current intensities in systems of contacted dissimilar metals in the oral cavity are appreciable must therefore be decided by experiments and experience.

An experimental set-up which allows the study of two dissimilar metals in direct contact is shown in Figure 1. The galvanometer used was a D'Arsonval type of a maximum sensitivity of 3×10^{-9} amperes (per millimeter of scale). Platinum, 24-carat gold, copper and silver amalgam were used as electrodes. The electrode surfaces in contact with the electrolyte ranged from 10 to 30 square millimeters and the distance between the electrodes was kept at 10 mm. Four different types of electrolytes were used: (1) 1 per cent sodium chloride solution; (2) constantly flowing 1 per cent sodium chloride solution, which was supplied from a tank; (3) saliva, and (4) the mouth of the investigator into which the electrodes were introduced.

It has been explained that the effects of polarization on a given system of electrodes cannot be derived theoretically, and it was not expected that the experiments would be absolutely reproducible. Reproducibility was reached only in the order of magnitude of current intensities.

In all experiments, current intensities were measured at given time intervals until the current intensity fell below 1 microampere (one millionth ampere). The results of these measurements are indicated in the accompanying table.

TIME AFTER WHICH CURRENT INTENSITIES FELL BELOW ONE MICROAMPERE

	In Sodium Chloride Solution	In Flowing Sodium Chloride Solution	In Saliva	In Mouth
Platinum/gold	5 seconds	5 seconds	1 second	5 seconds
Platinum/copper	1 hour	1 hour	20 minutes	30 minutes
Gold/copper	1 hour	1 hour	30 minutes	45 minutes
Gold/amalgam	48 hours	48 hours	1 hour	2 hours
Platinum/amalgam	48 hours	48 hours	1 hour	2 hours

This tabulation shows that current intensities reached the one microampere limit in less than forty-eight hours in every case. In most instances currents of the order of 0.1 or 0.01 microampere were reached during the time of the experiment. The results given in the last

column of the table are of especial interest, as conditions *in vivo* were closely imitated by placing the electrodes in the mouth of the experimenter and subjecting them to a constant flow of saliva, as well as to movements of the tongue and the jaws. Rapid movements of the tongue and hard biting on the electrodes increased current intensities two to three times; but after the time given in the fourth column of the table, no manipulation within the mouth increased the current intensity to more than 1 microampere.

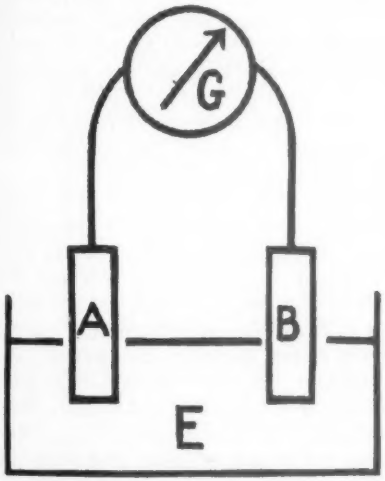

Fig. 1.—Experimental set-up for study of two contacting metals. A, first metal. B, second metal. E, electrolyte. G, galvanometer.

Figure 2 shows an automatic record of one of the experiments (platinum/gold in sodium chloride solution) on photosensitive paper.

The following *in vivo* experiment was carried out in order to establish the absence of appreciable amounts of current under normal conditions. We secured the cooperation of a patient who had a very large old amalgam filling (it was believed that the use of a newly made amalgam filling was undesirable in that it would not represent a truly average condition) in the lower right first permanent molar, restoring the mesial and most of the buccal surface. This patient also had mesial and distal caries of the second bicuspid and distal caries of the first bicuspid.

First, the mesioclusodistal cavity was prepared in the second bicuspid and left open. Then the distoclusal cavity in the first bicuspid was prepared and a gold inlay cast for it. A small hole was drilled in the inlay in the region of the contact point and the end of a 24-carat gold wire (about 2 cm. long) was soldered into it with 18-carat solder.

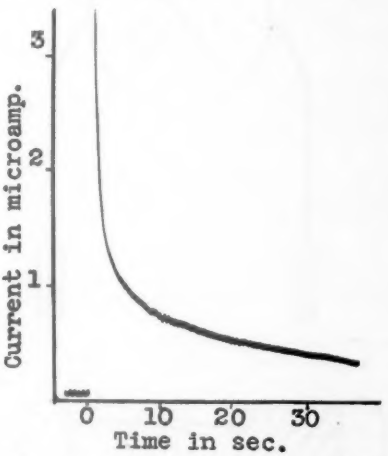

Fig. 2.—Automatic record of current-time measurement.

Next, a hole was drilled in the amalgam filling in the first molar, in the gingival third of the buccal surface. This was threaded with a suitable tap so that a previously threaded gold post (20-gage, gold and platinum clasp wire) could be screwed into it. To the short projecting end of this post, another piece of pure gold wire was soldered, identical with the one affixed to the inlay in the first bicuspid.

This post was then screwed securely into the amalgam, care being exercised to exclude saliva during the operation.

The edges of the threaded hole in the amalgam were then sealed with thinly mixed zinc phosphate cement. In this way, a binding post was secured that was in electrically tight contact with the brightened interior of the old amalgam, without recourse to new amalgam or any other intermediate substance.

The two pure gold wires leading from the two metal fillings were then twisted tightly together, while dry, and laid in the mesioclusodistal cavity in the second bicuspid, which was being kept open for that purpose, and covered with gutta-percha.

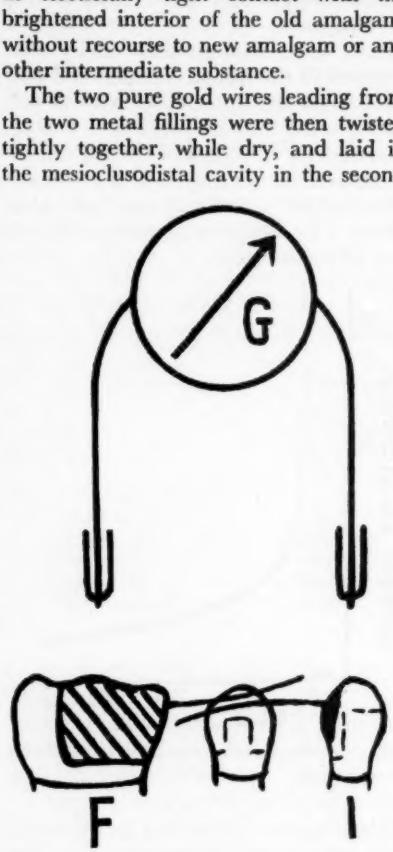

Fig. 3.—Experimental arrangement in mouth. F, amalgam filling. I, gold inlay. G, galvanometer with electrode points.

The experimental arrangement in the patient's mouth consisted now of a large amalgam filling and a gold inlay connected by gold wires. (Fig. 3.) The gold wires allowed free passage of galvanic current between the two dissimilar metals. Eighteen hours after both fillings had been thus connected, the following experiment was carried out in order to estimate the intensity of galvanic current flowing between the metals. Two gold electrode points, connected through a galvanometer, were placed on the amalgam filling and the gold inlay. The galvanometer showed no deflection because the current could pass through the original gold-wire connection of the fillings.

This connection was now interrupted by disconnecting the twisted gold wires. The two fillings were then connected only through the newly introduced gold electrode points and the galvanometer. Now a current reading could be obtained. At the moment of interruption of the original contact, the current reading was 1 microampere. The current intensity then decreased within two minutes to approximately 0.5 microampere. The original gold-wire connection was again established by twisting the ends of the two gold wires which were laid back in the mesioclusodistal cavity of the second bicuspid. As soon as this connection was reestablished, the galvanometer reading dropped to zero, thus confirming the close metallic contact between the amalgam filling and the gold inlay.

The experiment described was repeated in the same way one week after the first measurement. The current intensity was 1 microampere at the beginning of the reading and 0.6 microampere after two minutes, thus confirming the result of the first experiment.

This experiment shows that, under truly average conditions in the mouth, current intensities between connected gold and amalgam fillings are lower than 0.5 microampere (one two-millionth ampere). This is sufficient proof of the absence of appreciable amounts of current, since current intensities of that order have not been considered harmful

by those who have reported the results of similar investigations.

These observations are supported by the common experience that patients may carry gold and silver amalgam fillings in direct contact for more than ten years without any apparent decrease in the size of the fillings. If a current of only 1 microampere flowed continuously between the fillings, a silver amalgam filling of approximately 150 mg. weight should dissolve in four months according to Faraday's law. A statistical survey of 1,000 patients was recently published by Mills,[7] who found that the incidence of irritation of the oral mucosa was essentially the same for patients with dissimilar metal restorations as for patients having restorations of only one metal or no restorations at all.

3. The third group comprises dissimilar metals which come into intermittent contact. Such contact between a metal filling in the upper jaw and one in the lower jaw may be established intermittently during occlusion. The initial current readings of the experiments of Group 2 are of the order of 1 to 100 microamperes. A current of this intensity could be generated during the first moments of contact, and the pain reported in some cases of such intermittent contact may be due to this current.

A part of the reported experimental work was done in collaboration with Oscar Kanner,[6] who also made many suggestions for conducting the tests.

CONCLUSIONS

1. The presence of two or more dissimilar metals which are not in direct contact cannot give rise to galvanic currents.

2. The experiments conducted indicate that intensities of galvanic currents between dissimilar metals which are in direct contact are lower than 1 microampere. Galvanic currents of this order have not been considered harmful by previous authors.

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STUDIES OF DISPLACEMENT OF TISSUES UNDER DENTURES

By Carl O. Boucher, D.D.S., Columbus, Ohio

FOR a long time, I have been curious about what happens under denture bases under stress. I have felt that there was an appreciable cushion effect from the displaceability of tissue, because, otherwise, many dentures now in use could not be tolerated by their wearers. In order to measure the amount of tissue displacement, I determined to measure the amount of tilt of denture bases under different types of stress. It is obvious that, by this method, the total displacement cannot be measured, but merely the change in base relationship due to its displacement.

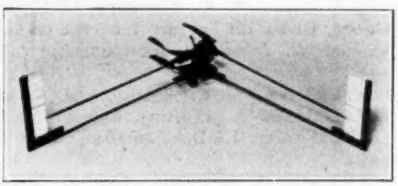

Fig. 1.—Tiltmeter.

A tiltmeter was devised to register graphically the change in relation of two denture bases when various stresses were applied. The instrument (Fig. 1) is so designed that it can be attached to completed dentures or to specially constructed bases. It consists of two adjustable horseshoe-shaped plates, which are attached to the denture bases by means of modeling compound. To these plates are connected pointers and graph-card holders. The pointers are connected by levers which magnify the tilt of the bases twenty-five times.

Figure 2 shows the central bearing pressure point and the plate which is used when the device is attached to the completed dentures.

The degree of tilting of the bases caused by tissue displacement will vary with different individuals, depending on the relative amount of soft tissue covering the bone. Also, when the ridges are flabby, the results will vary greatly.

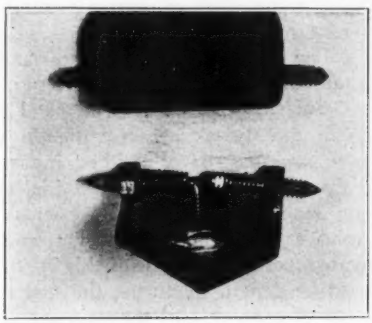

Fig. 2.—Adjustable central bearing plates.

Therefore, for these experiments, a patient was selected whose teeth had been out eight months. The ridges were firm and the tissues healthy.

A modeling compound plaster wash impression was taken of the upper arch. A modeling compound impression was taken of the lower arch in a transparent acrylic resin tray. On the casts made from these impressions, transparent acrylic bases were constructed. (Fig. 3.) The upper base was reinforced by a ridge from side to side in the first molar

Read at the annual meeting of the National Society of Denture Prosthetists, Milwaukee, Wis., July 1939.

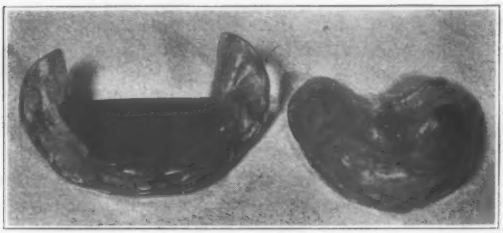

Fig. 3.—Transparent acrylic bases with built-in adjustable central or lateral point.

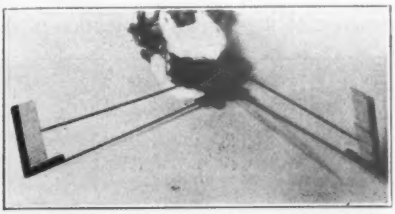

Fig. 4.—Tiltmeter attached to transparent bases on articulator.

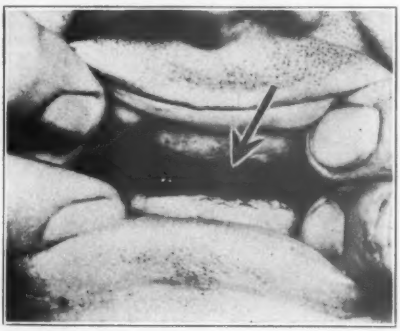

Fig. 5.—Central bearing point in place with no pressure.

areas. Nuts were placed in this ridge at the first molar position on the left side and in the center of the base as a means of attaching the central and lateral bearing points to the base. A brass plate was attached to the lower base across the arch in the first molar and second bicuspid areas, serving as a bearing surface for pressure applied by the bearing points of the upper base.

Figure 4 shows the bases and the tiltmeter mounted on an articulator. Figure 5 shows the bases in place in the mouth with the central bearing point under no pressure. Figure 6 shows the same bases under hard biting pressure. The blanching of the tissue indicated that blood had

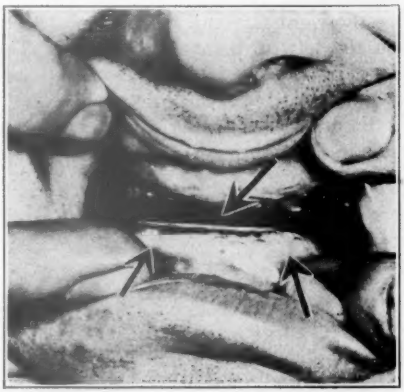

Fig. 6.—Central bearing point in place with pressure.

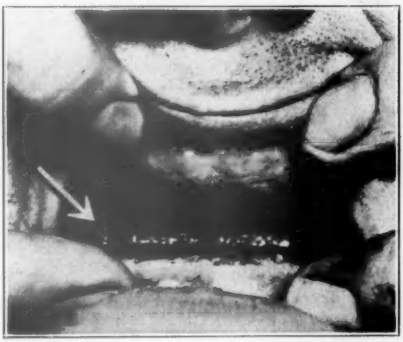

Fig. 7.—Lateral bearing point in place with no pressure.

been forced from the tissue under the base. This causes a change in relation of the bases to each other, as will be shown later.

Figure 7 shows the same bases with a lateral bearing point and no pressure. Figure 8 shows the effect of pressure on the lateral bearing point. Figure 9 shows the blanching of the tissue when the force is applied to incline planes of molar teeth. First molar teeth were set on the right side and second molar teeth on the left, in balanced occlusion. The force was applied upward and laterally against the upper teeth.

Figure 10 shows the tiltmeter in position in the mouth.

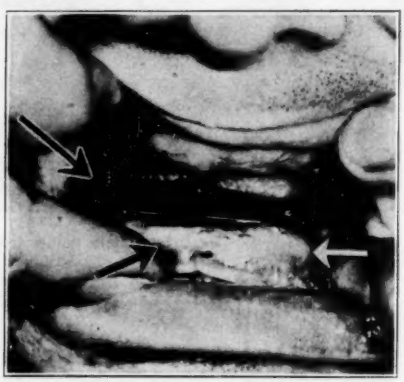

Fig. 8.—Lateral bearing point in place with pressure.

Maximum pressure on the central bearing point produced no change in the position of the lateral pointer and only a 1.5 mm. change in registration of the anterior pointer. This means that tissue in the mouth was displaced so that the bases were only 0.06 mm. closer together in the anterior region under pressure than without pressure.

When the maximum biting pressure was exerted on the lateral bearing point, the registration of both pointers was changed 2 mm. This shows a displacement of tissue amounting to only 0.08 mm.

The results of these experiments were entirely different from what was anticipated. The tilt of the bases in relation to each other was much less than was expected. This can only mean that other conditions than tissue displacement compensate for most of the errors in occlusion built into dentures. Probably the greatest of these is a combination of the tactile sense and the muscle tendon sense. These two senses guide the mandible and the teeth into some sort of occlusion that is tolerated by the tissues, and limit the amount and type of pressure on the dentures.

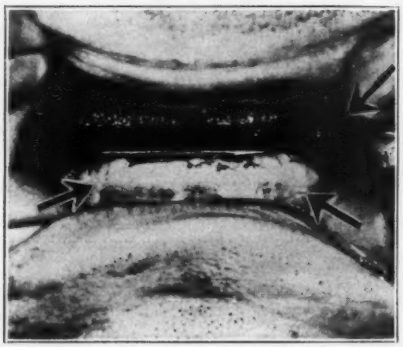

Fig. 9.—Left upper and lower first molar in incline plane contact with pressure.

Fig. 10.—Tiltmeter in place.

317 Beggs Building.

COMPOSITE ODONTOMA

By KEITH L. BUECHELE,* Ph.G., D.D.S., St. Louis, Mo.

ODONTOMA may be defined as a tumor the structure of which resembles the normal structure of the teeth and therefore may consist of enamel, cementum and dentin. It may be embedded in the jaw or partially erupted. It should be noted that these tumors are separated from the surrounding bone by a fibrous capsule.

From the clinical and histologic standpoint, it may be useful to classify odontomata into two main groups according to Partsch: (1) the soft odontoma and (2) the hard odontoma.

Fig. 1.—Odontoma extending into mandible.

Whether a hard or a soft odontoma is developed is dependent on the period in which the tooth bud suffered pathologic change. No one can state definitely the exact cause of odontoma, but probably trauma or other irritation contributes to its development. The earlier this pathologic change takes place, the softer the structure will be. There is no strict border line between the two groups, and smooth transmissions are observed in some cases.

While the so-called ameloblastoma is characterized by excessive growth of the enamel epithelium, the soft odontoma is developed by excessive activity of the mesodermal components of the tooth bud. The arrangement of the soft tissues of the tooth bud may be so regular that at times several well-developed tooth buds will be found grouped together. These connective tissues may, in the later stages of development, produce a homogeneous substance which later on may be calcified, and so the soft odontoma may be changed into the hard type. The structure of the hard odontoma resembles the normal structure of the teeth, but is so irregular in arrangement that malformations are easily observed. It may be found embedded in the jaw, or partially erupted.

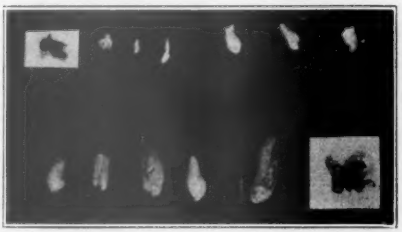

Fig. 2.—Eleven malformed teeth found in odontoma.

REPORT OF A CASE

History.—A man, aged 31, of English

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descent, in good general health with six lower anterior teeth vital and of normal appearance and the gingivae normal in tone and color, showed a slight enlargement in the region of the lower left lateral incisor.

Examination.—Roentgenographic examination disclosed the presence of an odontoma between the lower left lateral incisor and the lower left cuspid extending rather deeply into the mandible. (Fig. 1.)

Operation.—Under conduction anesthesia, a large mucoperiosteal flap was made, the labial bone was carefully chiseled away and the odontoma was removed, complete with the fibrous sack. It contained eleven malformed teeth shaped like cuspids and premolars. (Fig. 2.) (The removal of the fibrous sack in its entirety is very important. Rywkind describes a rare case in which remnants of the connective tissue capsule gave rise to other hard malformations.) The bone was smoothed with files and curets and packed lightly with iodoform gauze and the flap returned to position and sutured. After two days, the pack was removed and, after four days, the sutures were taken out. A postoperative roentgenogram was taken.

Outcome.—Healing was uneventful. (Fig. 3.) The patient has been seen at intervals of one month. The teeth are vital and a roentgenogram shows the filling in of new bone. (Fig. 4.)

Fig. 3.—Postoperative condition of healing.

Fig. 4.—Filling in of bone.

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6623 Lillian Avenue.

ANAEROBIC HEMOTOXIN-PRODUCING STREPTOCOCCI IN PYORRHEA AND LUNG ABSCESS

By Edwin J. Grace, M.D., F.A.C.S., Brooklyn, N. Y.

In lung suppuration, irrespective of the stage at which the patient is seen, the bacteriologic picture is confused, whether the bacteria reach the lung by aspiration or are borne by the blood stream. The former theory seems more logical. In more than 90 per cent of experimental animals under anesthesia, it is noted that methylene blue promptly and easily passes down into the lung, carrying with it infected débris and bacteria from the mouth.

This being true, the relative infrequency of lung abscess in proportion to the number of operations performed under general anesthesia is amazing, and emphasizes the efficiency of pulmonary tissue defense. On my service at the Kings County Hospital, I have observed that patients with lung abscess, especially the chronic and putrid type, have invariably had dirty mouths, with marked evidence of pyorrhea, and I have felt that a definite clinical relationship existed between the two entities.

In 1937, under particularly favorable conditions for bacteriologic tests, thirty-five cases of lung abscess of all types were studied with critical anaerobic technic. In 90 per cent of the cases studied, an anaerobic hemotoxin-producing streptococcus was isolated. Although this finding was of clinical interest, it did not alter the fact that operation on the lung had to be resorted to. But, in view of the constant association of pyorrhea with lung abscess, further investigation, using a comparable bacteriologic technic, seemed warranted.

We now have a series of ten cases of lung abscess in which the abscess cultures showed anaerobic hemotoxin-producing streptococci. In each of the ten cases, the mouth is pyorrheic and foul. Cultures were taken from the gums and the same streptococcus was found.

This striking coincidence, if such we can term it, seems to us to present a very formidable challenge to the dentist. The question immediately arises: How many cases of lung abscess might be prevented by proper and early care of pyorrhea? Recent years have found physician and dentist working with increasing cooperation; and this seems an added reason for so doing.

If my deductions are correct, it would seem that this anaerobic streptococcus obtains a perfect medium for growth in the depths of the gingival border and recesses, and it continues its destruction as long as it has this perfect medium. All clinical signs and symptoms of pyorrhea can follow this bacteriologic phenomenon and, in my opinion, the cause of pyorrhea is possibly this anaerobic hemotoxin-producing streptococcus, and the host of other organisms described are probably all formidable secondary invaders. In chemotherapy, we have two excellent agents for dealing with this type of streptococcus: (1) sulfanilamide, which has almost a specific effect on this organism, and (2) zinc peroxide, which alters the medium from a destructive toxic anaerobic one to a relatively normal or harmless aerobic medium. In ten cases, I have used a paste of sulfanilamide and another of zinc peroxide, and these have been employed alternately every two hours by the patients, reaching with a toothbrush well into the pyorrheic pockets. Since the immediate response has been most satisfactory, we believe that this therapy should be the subject of further study.

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TREATMENT OF DRY SOCKET: A PRELIMINARY REPORT

By William E. Shea, M.D., San Francisco, Calif.

THE following cases were referred to me by Norman A. Lussier, D.D.S., of San Francisco. They were diagnosed, after extraction, as dry socket, and the patients were examined by Dr. Lussier after treatment with vitamin B (thiamin 333 I. U., 1 mg.). His notations and mine are appended in a résumé of these cases.

CASE REPORTS

Mrs. E. B., aged 38, had an impacted tooth removed under local anesthesia, April 26, 1940. Pain developed April 29 and dressings were applied that day and the following day. May 1, the socket was redressed and vitamin B 10,000 units was given intramuscularly. There was no pain after the injection.

Mr. A. J. S., aged 37, had an impacted tooth removed under local anesthesia, April 19, 1940. Dressings were applied daily, April 20-25. April 30, 10,000 units of vitamin B was given. There was no pain after the injection.

L. L., a girl, aged 10, had a tooth extracted under gas, April 27, 1940. Dressings were applied May 1 and 3. Vitamin B 5,000 units was given May 3. There was no pain after the injection.

Mr. B., aged 41, had a lower left molar extracted under local anesthesia, April 27, 1940. Dressings were applied May 2 and 3 and vitamin B 10,000 units was given May 3. There was no pain after the injection.

Mrs. S., aged 32, had an impacted tooth removed under local anesthesia, April 4, 1940. Dressings were applied April 26-May 2. May 1, vitamin B 10,000 units was given, with little relief.

Mr. K. L. McL., aged 23, had a tooth extracted under local anesthesia, April 16, 1940. Pain was present before extraction. A dressing was applied April 19, and April 22 vitamin B 10,000 units was given. There was no pain after injection.

Mrs. G. C., aged 54, underwent a difficult extraction, April 29, 1940, under local anesthesia. The socket was treated May 2-8 with the infrared rays. May 7, vitamin B 10,000 units was given. Pain returned after forty-eight hours, but relief was obtained after a second injection. Dressings were continued.

Miss H., aged 23, had a tooth extracted under local anesthesia, May 3, 1940. Dressings were applied May 6-8 and vitamin B 10,000 units was given, with no relief.

Mr. F. McG., aged 41, had a tooth extracted April 24, 1940, under local anesthesia. Vitamin B 15,000 units was given and there was no pain thereafter.

Mrs. J. C., aged 24, had a tooth extracted May 16, 1940. A dressing was applied. Severe pain was present. May 18, vitamin B 10,000 units was given. The patient was able to sleep through the night after taking 10 grains of acetyl salicylic acid. May 19, she was given 20,000 units of vitamin B, with relief from pain. The following day, she was given 50,000 units, and, up to the present time, she has been free from pain. In an earlier case of dry socket, she did not get relief from pain on administration of morphine sulfate 0.065 gm. At that time, she had been dieting to reduce her weight.

Mr. J. H., aged 26, had a tooth extracted May 11, 1940, under local anesthesia. Vitamin B 10,000 units was given and there was no pain thereafter.

Mr. J. A. C., aged 23, underwent extraction of impacted teeth, May 7 and 9, under local anesthesia. Vitamin B 10,000 units was given after each extraction. There was no pain following the injections.

Mr. M., aged 24, had an impacted tooth extracted May 10 under local anesthesia. Dressings were applied May 13-18. May 15, vitamin B 10,000 units was given, and, as he did not have any pain after the injection, the patient refused to have another injection.

Mr. R. V., aged 31, had a tooth extracted May 5, the extraction being followed by injection of vitamin B, May 10. There was no pain after the injection.

450 Sutter Street.

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L. PIERCE ANTHONY, D.D.S., Editor

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THE NEW HARVARD DENTAL EDUCATIONAL PLAN

THE year 1940 is an epochal one in dental circles as the centennial of the organization of dentistry into a professional health service to humanity. We have been busily engaged during the year in singing our praises in celebration of the accomplishments of dentistry in its first hundred years, beginning in the history-making centenary celebration at Baltimore in March, and we shall continue the celebration as the theme of the Eighty-Second Annual Meeting of the American Dental Association to be held in Cleveland in September.

In the midst of our joyous celebrating, now comes a jarring and disillusioning note from Harvard University calling attention to our professional shortcomings and announcing the belief that the educational plan at present being pursued in dentistry fails of accomplishment of its desired end, and, as a consequence thereof, Harvard proposes a new plan of dental education with an entirely new conception of the purposes and aims of dentistry and an entirely new objective in its educational product.

The essential features of the so-called Harvard dental educational

plan, as we have been able to interpret the statements thereon, official and unofficial, are:

(a) The establishment, as a preparation for dentistry, of a basic educational course to be essentially identical with the basic course now being given in the medical school as a preparation for medicine.

(b) The abolishment of the separate instruction of dental students in the basic preclinical and clinical subjects of medicine; the courses in these subjects to include both dental students and medical students, and the total number of students to be determined by subsequent faculty action.

(c) The preparation of a small number of highly qualified men for certain particular opportunities now existing in the dental field: teaching, research, special types of practice, general practice and public health.

(d) The development in hospitals and other dental clinics of opportunities for further training after graduation; also the anticipation that a number of teaching and research fellowships will be established. (This is one of the changes that tends to bring dental educational methods in line with the methods and standards of medical education since, after all, the medical school does not attempt to equip its graduates in general with complete technical proficiency.)

(e) A plan to add one year to the training now required for dentistry, making a total period of five years, the students fulfilling the requirements of the five-year course to receive both the M.D. and the D.M.D. degree. (During the five years, they will receive about three and one-half years of the present medical course and about one and one-half years of specific dental training. Some specific dental training will be given during each of the five years.)

(f) Admission this coming September of the last class to enter the present four-year dental curriculum, the new plan to go into operation in the fall of 1941.

(g) The abolishment of the present four-year course in the Harvard Dental School and transformation of the Harvard Dental School in substance and name into the Harvard School of Dental Medicine.

We hesitate to contemplate the effect upon dentistry of the institution of such a plan of so-called dental education. We make no special claims as a seer as regards the future of dentistry as a profession, but we believe it to be clear to all who have followed the fortunes of dentistry and dental education that the adoption of such a plan as here proposed

will mean virtually the abolishment of dentistry as we have come to know it, and as we believe it can best serve its health service objectives.

The question at issue appears to be the technical aspect of dental practice as a drawback to professional stature. The essence of this stricture placed on dentistry by some members of the medical profession and a few in the dental profession who aspire to medical status is that the necessity for the development of technical skill required in the present plan of dental education precludes the possibility of dentistry becoming a branch of health service on a cultural and professional equality with medicine.

In an effort to meet this criticism, the educational system, or rather the conception of dental health service, has undergone a radical change. From the very inception of dentistry, this critical attitude on the part of medicine has exerted an influence on dental education toward the subordination of the technical phase, until about two decades ago, when the interdependence of the biologic aspect of dentistry and the technical was fully realized. The trend of dental education since then has been definitely toward the development of an educational plan that would combine the biologic and the mechanical conceptions, and the product of this educational procedure had led us to believe that this course was increasingly successful as it was being developed.

Now, however, we are told that our educational efforts have failed to produce a profession on a par socially or professionally with the present medical profession; that we are mostly a group of technicians with little or no appreciation or understanding of the biologic conception of dentistry as a health service—and the irony of the situation is that this *ex cathedra* proclamation comes from the medical school of the university which has prided itself on being the first to include dentistry in its university discipline. Shades of Keep! That grand old educational pioneer who was among the first dental practitioners to realize the important relation that dental health service has to general bodily health! It was largely through his efforts that Harvard first established a dental school. Now, however, Harvard has had such a revulsion of attitude that it is ready and apparently eager to abandon the present plan of dental education in favor of a plan that can produce only medical dentists.

We are not ordinarily given to comparisons, for we duly recognize their odiousness, but the implications of this plan that the educational requirements for dentistry should be more than for medicine or any of its specialties impels us to what we believe to be a pertinent comparison of the present dental and medical educational requirements.

The present standard educational requirement for the dental course is four years of intensive training under a dental curriculum that embraces all of the sciences, including bacteriology and bacteriopathology, that are fundamental to the medical as well as to the dental curriculum. The medical course likewise requires four years for completion of the standard curriculum leading to its distinctive degree. Thus it will be seen that as long a course of training is required to properly educate the dental student in the data relating to the mouth and its contained organs as is required for the medical student to acquire knowledge of everything else pertaining to the human organism apart from the mouth.

We do not concede that this difference in the scope of the two curricula of equal length implies any difference in the intellectual capacity of the student material concerned with the study of medicine or dentistry. It does, we believe, connote the fact that, given equal intelligence to start with, the dental student, after four years of intensive study of his special field, will know more about the data of his profession than the medical student, who has been led to believe that he can encompass a knowledge of the entire human organism in the same period of time, will know of the principles of his profession.

We are in no manner in accord with the implication so often heard, as in the instance of the committee which proposed the new Harvard plan, that the technical phases of dentistry disqualify it as a cultural profession or that it decreases in any degree its importance as a health service.

The fact that the dentist performs an important and essential part of his service with his hands should not *ipso facto* be a source of discredit from the point of view of professional service any more than the same fact as it applies to their service should discredit the laryngologist, the ophthalmologist and the surgeon. The restorative phase of dentistry is essential to the curative therapeutic aspect. If a tooth becomes infected and metastatic lesions or general pathologic conditions result therefrom, the course of therapeutic procedure is sterilization and restoration, or extraction and prosthesis. There are no alternatives: both involve mechanical dentistry in the broad sense, and any system of dental education which does not make ample provision for thorough training in dental operative procedures to the therapeutic end defeats its own purpose.

As the medical profession persistently refuses to recognize this important relation of the technical aspect of dental practice, it is clear to us that the safe and sane procedure in dental education is for dentistry to develop its own curriculum and one adapted to its particular needs;

that is, to turn out the most intelligent and skilful dental practitioner, which we are convinced cannot be done in the medical school and with the present curriculum, or even with one year added.

In the proposed Harvard plan, the need for more dentists is recognized, and the suggested manner of meeting the need is as conspicuously inconsistent as are many of its other phases. The committee which is responsible for the proposed plan admits that the present physical equipment of dentistry is inadequate to meet the need and, at the same time, proposes a plan of educational procedure that will seriously reduce the number of new graduates coming into the profession. We are firm in the belief that, quite contrary to the views expressed by the committee, the avenues of entrance into the dental profession should be made less difficult, not by any compromise in the matter of educational standards, but by the adoption of educational requirements logically adapted to securing matriculants having the best kind of training for entrance upon the professional course.

Also, we believe that the present proposed plan will divert men from dentistry into medicine, that it will eliminate another dental school and that it will decrease by that much the number of men entering dentistry—and to that extent delay dental education in the attainment of its present professional educational objective.

It is apparent that in the projected plan, devised mostly by medical men and from a strictly medical conception of dental education, the dental profession is singled out to be the recipient of a discipline that medicine has from its beginning attempted to impose on any and all phases of health service that have not procured their training and degree as a recognized medical specialty. Medicine, even from the days of 1840, has assumed, with questionable justification, that any devotee of the science and art of healing who has not pursued the accepted and conventional curriculum of training that terminates in the medical degree is, by virtue of that fact, unqualified to practice any specialty of the healing art; and that his judgment, even with regard to his special field is not entitled to respectful attention by those who hold the medical qualification.

Professional prejudice, the instinct of self-preservation, fanatical adherence to an ancient and hopelessly senile ideal on the part of the medical profession have largely delayed but have not prevented the recognition of dentistry as a legitimate health specialty. Now, however, we have a recrudescence of that prejudicial attitude from a source that, by virtue of its background and traditions in the educational field,

should be devoting its efforts to forwarding rather than inhibiting the development of dental health service.

The vicissitudes of dental education in development of educational programs that will best equip the graduate to meet the requirements of dental practice as at present conceived have taught the educators one thing at least that should stand them in good stead in meeting the educational needs of the future; namely, that our development must be of our own making; that the educational scope of dentistry must be developed by dentists for dentistry, and that we must continue to build on the dental foundation that was so soundly laid one hundred years ago.

We have long realized the fact that lack of attainment of the preventive goal of dentistry has been due to the lack of funds available for scientific research. Several of the large foundations and individual philanthropists have made funds available for dental educational and research purposes, but the funds have, in many instances, been so bound up with medical restrictions and medical educational implications that they have failed to accomplish their dental purposes.

While we commend highly the direction of funds toward dental educational and scientific development, it is indeed difficult for us to evince much enthusiasm for a project apparently intended to submerge dentistry in medicine by the diversion of its educational and professional aims in a manner that is, we believe, subversive of the interests of dentistry and the interests of the public health.

OBITUARIES

CHARLES ROSS LAWRENCE, D.D.S., F.A.C.D.

(1876-1940)

CHARLES ROSS LAWRENCE died at his home in Enid, Okla., August 6, 1940. He was born in Noble County, Ohio, April 27, 1876, and attended the Ohio College of Dental Surgery and the Cincinnati College of Dental Surgery, graduating from the latter institution in 1897. Immediately after graduation, he began the practice of dentistry at Bethany, Ill. In 1902, he became a member of the Illinois State Dental Society. About 1904-1905, he assisted in organizing the Macon-Moultrie unit of the Illinois State Dental Society, under the reorganization plan of the state society.

Dr. Lawrence had the honor of reading the first paper presented before the Macon-Moultrie Dental Society: "The Dental Society as a Necessary Factor in Professional Growth." This paper was published in the *Dental Review* shortly after that meeting.

He was secretary of the Macon-Moultrie District society for two years, and kept up his membership in the Illinois State Dental Society after leaving the state in 1908. In 1927, he became a life member.

Dr. Lawrence moved to Enid, Okla., in November 1908. In 1909, he became a member of the Oklahoma State Dental Society. He organized the Northwestern Oklahoma Dental Society in 1910; was elected president of the Oklahoma State Dental Society in 1911, and was president of this society (1912) when it made a radical departure in the plan of conducting its meetings and established what later became known as the post-graduate plan or "Oklahoma Way" of conducting dental meetings.

Dr. Lawrence was the organizer and promoter of the Tri-State Dental Meeting in Kansas City in 1916, a special joint meeting comprising Missouri, Kansas and Oklahoma and taking the place of the regular annual meetings of these states for that year. This meeting was attended by dentists from eighteen states as well as one dentist from Canada and one from Mexico.

Dr. Lawrence prepared the program and made the call for the first conference of state society officers, at the national meeting in Kansas City, in 1913. As a result of this conference, the House of Delegates created a new section at this meeting known as the State Society Officers Section. He became a member of the House of Delegates in 1917 and had continued to act as a Delegate up to the time of his death. He was a member of the Judicial Council from 1917 to 1931; Vice President of the American Dental Association in 1933, and a member of the Board of Trustees from 1933 to 1939. He was elected to fellowship in the American College of Dentists in 1933.

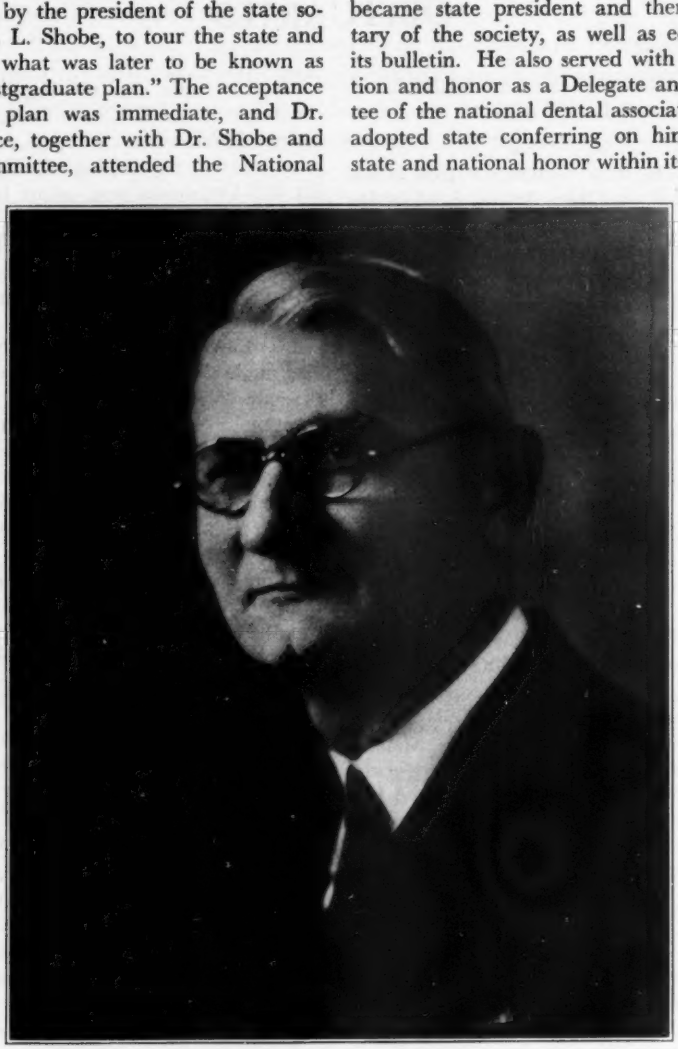
A TRIBUTE

IN the death of Dr. Lawrence, his family has lost a faithful husband and father, scores of men and women have lost a true friend and the dental profession has lost one of its most colorful, enthusiastic, inspiring members and teachers.

Lawrence (as we who knew him best called him) came to Oklahoma while the state was still young, bringing with him a sincerity and definiteness of purpose together with most exceptional ability as an organizer. Identifying himself with the state society, he took his place first as a private in the ranks of organized

dentistry, but was later one of five men selected by the president of the state society, B. L. Shobe, to tour the state and explain what was later to be known as the "postgraduate plan." The acceptance of this plan was immediate, and Dr. Lawrence, together with Dr. Shobe and the committee, attended the National Dental Association meeting that year and selected those who were to conduct the course.

Dentistry throughout the world has benefited by this plan, and C. R. Lawrence was largely responsible for its introduction to the profession. Later, he became state president and then secretary of the society, as well as editor of its bulletin. He also served with distinction and honor as a Delegate and Trustee of the national dental association, his adopted state conferring on him every state and national honor within its power.



C. R. LAWRENCE

In addition, he served as a member of the state executive council through the years, being the recognized balance wheel of that body. Always stable, calm, dispassionate, he never failed to demonstrate that his highest interest was the

welfare of dentistry, with the inevitable result that he was respected, not only by every man within the state, but also by the profession at large.

He was one of those men who took life and work seriously but joyfully. His love and appreciation of the worth while things in life endeared him to all those whom he inspired to become better dentists and better business men. He believed that "the laborer was worthy of his hire" only when the service was commensurate with the fee.

What his philosophy of life was, I do not know, nor do I care to know. I do know that it sustained him throughout his travels here; that he traveled well and far and never alone—he always carried others along with him.

His family will miss him and mourn his passing. You and I will note his vacant seat in the councils of dentistry, and when his profession pays final tribute to one of its most noble characters, we shall be unashamed of the tears in our eyes and the sorrow in our hearts.

C. R. Lawrence is gone, but will continue to live and not only with those whom he knew personally, not only with those whom he taught so earnestly. Future generations will be better citizens, better dentists, because of him. Words seem such futile things, but you, Lawrence, somewhere out there, you with your understanding soul, you will know and feel what is in our minds and hearts when you hear, "Peace be with you."

A. L. WALTERS.

JOSIAH GASTON FIFE, D.D.S.

(1861-1940)

J. G. FIFE, D.D.S., F.A.C.D., died in Orange, Texas, June 27, 1940.

Born in Monticello, Fla., in November 1861, Dr. Fife's early manhood was spent in the lumber business in Georgia. He entered the Baltimore Dental College in 1889 and graduated from that institution in 1891. After graduation, he went to Dallas, Texas, where he practiced from 1891 to 1918, when ill health made it necessary for him to retire from active practice.

He joined the Texas State Dental Society in 1891, his first year of practice, and continued a member until his death. He served as secretary-treasurer of the society from 1895 to 1901. In 1903, he was elected president of the society. In 1907, he was again elected secretary-treasurer, serving until 1914. In 1917, he was again elected secretary-treasurer, serving until 1937, at which time he became too ill to continue the duties of the office.

JOSIAH GASTON FIFE

Dr. Fife was one of the dominant factors in the history of the Texas State Dental Society. Under his guidance, the society prospered and dentistry in the Southwest progressed. He was well known to the profession for his enthusiasm for postgraduate studies presented by state societies for the benefit of the member-

ship, he being a pioneer in this work. Dr. Fife administered to happiness and to service. A reserved, scholarly gentleman of the old school, his motto was "The Golden Rule." No life of the average man ever exemplified stricter adherence to the right than his. He loved his fellowman and his fellowman loved him. The membership of Texas depended upon him. His feet were firmly rooted to the good earth and he knew the secret of serenity and peace.

Dr. Fife is survived by one brother, of Jacksonville, Fla., and one nephew, Dr. Tom F. Coyle, of Orange, Texas.

WILLARD OGLE.

DEATHS

BRENNAN, FRANK DOMINIC, Ashland, Wis.; died March 26; aged 80.

BUCK, MINNIE G., Chatham, Mass.; Temple University School of Dentistry; died May 24.

CAMPBELL, C. F., Stevens Point, Wis.; Marquette University Dental School, 1904; died April 26; aged 61.

CLEMENS, CLAUDE C., Durand, Wis.; Chicago College of Dental Surgery, 1902; died March 26; aged 60.

FREEMAN, HENRY D., Wareham, Mass.; University of Pennsylvania, School of Dentistry, 1908; died June 1.

HILLS, ALFRED, COOKMAN, Toledo, Ohio; Pennsylvania College of Dental Surgery, 1900; died March 13; aged 68.

HOMAN, ERNEST W., Lynn, Mass.; Tufts College Dental School, 1902; died July 3.

JAMES, KARL YOUNG, Bucyrus, Ohio; Ohio State University College of Dentistry, 1903; died April 9; aged 60.

KEACH, FREDERICK P., Salem, Mass.; died May 1.

LASENBY, ORLO J., Rochester, Mich.; Detroit College of Medicine, Department of Dental Surgery, 1900; died June 19.

LOIZEAUX, JEAN J., Boston, Mass.; Boston Dental College, 1893; Tufts College Dental School, 1906; died April 15.

MCDONALD, A. J., Chicago, Ill.; Chicago College of Dental Surgery, 1914; died July 12.

MARSHALL, C. R., Columbus, Ohio; Ohio State University College of Dentistry, 1914; died May 10; aged 51.

MARTIN, JAMES F., Springfield, Mass.; Harvard University Dental School, 1896; died in June.

MILLER, ROBERT M., Boston, Mass.; Temple University School of Dentistry, 1896; died June 26.

MOELLER, FREDERICK M., Iola, Wis.; Northwestern University Dental School, 1901; died March 19; aged 73.

NOWACKI, STANLEY J., Grand Rapids, Mich.; Marquette University Dental School, 1912; died recently; aged 55.

PAUL, JOSEPH T., Boston, Mass.; Harvard University Dental School, 1891; died May 11.

PETERSON, G. A., Shawano, Wis.; Marquette University Dental School, 1931; died May 31; aged 35.

RANSIER, WAYNE A., Hardin, Mont.; Chicago College of Dental Surgery, 1913; died recently; aged 48.

RICHARDSON, WALTER H., Worcester, Mass.; University of Pennsylvania School of Dentistry, 1897; died May 9.

SANBERG, FRANK E., Chicago, Ill.; Northwestern University Dental School, 1903; died June 24; aged 60.

WESTFALL, MARY H., Indianapolis, Ind.; Northwestern University Dental School, 1917; died August 4; aged 59.

ZEHRUNG, HARRY M., Connersville, Ind.; Indiana University School of Dentistry, 1891; died recently; aged 77.

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President's Message

LAST CALL FOR CLEVELAND

WITHIN a week after this message finds its way into the hands of our members, the American Dental Association will be in session at its annual meeting in Cleveland. For more than a year, innumerable committees have been at work in an effort to make this annual gathering an event of more than usual interest. In the first place, it will commemorate the birth, development and achievements of American dentistry during the first century of its existence as an organized profession. It will also afford an opportunity for every member of the Association to participate in the celebration of one of the most important events in the history of the profession. It should stir the imagination of every one present and send him back to his home fired with a new resolve to do his part in promoting the onward march of dentistry. No member can afford to miss this celebration of the centenary of his profession.

In the second place, and in keeping with this important event, a special effort has been made to prepare a program that will be unique. The general sessions, as already indicated, will be addressed by men of distinction in their respective fields. Senator Murray of Montana, who last March introduced a bill into the U. S. Senate to provide federal funds for research in dentistry, will address the opening session. He will be followed by Norman Vincent Peale, of New York, who will speak on the "Art of Living." In these days of world-wide turmoil, it is appropriate that we should pause in our deliberations to consider the meaning of life and our part in making it worth while.

Frederic Snyder, a war correspondent and world traveller, will interpret for us current events. No one can do this more interestingly than he. At the last session, Earnest A. Hooton, professor of anthropology at Harvard, will bring to us a message of more than usual interest. This he will do in an informal lecture, illustrated with slides.

The scientific sessions too will be of a high order and in keeping with the occasion. Nothing has been spared to make them of interest to every member. More than 125 scientific and historical exhibits

will add to the interest of this part of the program, which will probably surpass anything of its kind ever before displayed at an A.D.A. meeting. The historical feature of the exhibit will be unique, representing as it will a hundred years of progress. To those who were not fortunate enough to see it in Baltimore, this exhibit will be a rare treat.

The Local Arrangements Committee has left nothing undone to make the meeting in Cleveland an outstanding success. Only the attendance of our members in large numbers is needed to make this anniversary meeting of the American Dental Association memorable. By his presence, every member of the Association can make a substantial contribution to its success. This is a duty which each owes to himself, his profession and his patients. A registration of more than ten thousand is expected by the Local Arrangements Committee.

And now, a word in closing: During the past year, it has been my privilege as President of the American Dental Association to keep in touch with our members through the pages of our national and state journals, and by attendance at many dental meetings. This I have done in order to keep the membership informed regarding the activities of our national Association and the ways in which each member could cooperate in making its work more effective. The task has been a pleasant one and the results gratifying. The work of the Association has gone forward, its membership has increased and its opportunities for widespread service are greater than ever before.

My official duties are nearly finished. Another must soon carry on from where I leave off. For my successor, I can ask no more than that you give to him the same support that you have so generously given me. With your continued cooperation, he will be able to advance the profession beyond its present standards. In this way, progress is made.

In conclusion, may I, in this last presidential message, express to the members of the Association my thanks and appreciation for their loyal and enthusiastic support. It is this willingness on the part of our members to support and carry on the work of organized dentistry that insures the continued progress of the dental profession.

Arthur H. Merrill

BUREAU OF PUBLIC RELATIONS

THREE TO SIX APPEAL

By W. J. Pelton,* B.S., D.D.S., M.S.P.H., Washington, D. C.

"IT'S no fun being good."

"Doing the things I ought to do are boring."

These two statements, coupled with the normal fear reaction produced by a dental office environment and the unpleasant tales heard about the dentist, have a great deal of influence on the child's reaction to visiting the dentist.

It has been shown by Jersild[1] that children's wishes, likes and pleasant memories include toys to such a degree that the dentist may well consider that the child's receipt of a gift in his office is an important event.

Stoddard[2] has shown experimentally that praise added to a successful performance, improved subsequent performances and that a gift improved performance still further. Transferring this situation to the dental office, praise of the child's response to dental treatment should color favorably his response toward future treatment. The receipt of a souvenir should tend to promote even better cooperation on the part of the child.

In other experimental work,[3] Jones demonstrated that children's fears could be eliminated by associating the feared situation with a desired situation. Since Jersild has shown toys to be desired objects, children who already fear a dental office may no longer shrink from a dentist who has given them a toy after the dental appointment.

From the foregoing, it is evident that being good in the dental office can be fun, and a souvenir tends to take the "bore" out of a boring dental appointment. Furthermore, a gift contradicts some of the unpleasant stories the child has heard about the dentist and helps to make the dental office an interesting place.

Although a psychiatrist would probably tell those of us who give a child a memento of his dental appointment that we are treating ourselves, that we are inflating our own ego and that such a technic gives us a feeling of power, many psychiatrists of good repute recommend a "star chart" as an aid in helping children overcome enuresis.[4] The "star chart" is a pure form of reward, since the child receives a star only on the nights during which he does not wet the bed. Properly, in a dental office, souvenirs are given to a child regardless of his past behavior, in order to influence his future behavior.

Other groups also rightfully object to the use of "honor rolls" in classrooms to record dental treatment, on the ground that they are bribes and rewards which discriminate against indigent children, who are not responsible for their inability to purchase dental care. Some critics believe that the name on the honor roll is stressed rather than the health reasons for having the teeth treated. More to the point is the criticism that once a child has his name on the "honor roll," his interest in further dental treatment ceases. Obviously, dental health is not a sta-

*Passed Assistant Dental Surgeon, U. S. Public Health Service.

tionary condition and frequent treatment is the aim of any good program. Therefore, it would seem that the use of "star charts," "honor roll" and "blue ribbon" methods in schools is not justified because it defeats its own purpose.

The dentist's use of souvenirs falls into a different category. He gives his juvenile patient a gift to help make dental service pleasant and the dental office a place where interesting things do happen.[5] He presents the child with a coveted piece of property to fulfil for him a subconscious wish, as well as to condition him favorably for further dental treatment. By this means, he stimulates the child to return at frequent intervals for further treatment.

Gifts, such as dolls, boats and certain books (comic strips), have been criticized because they have no connection with dentistry. In place of those gifts, it has been advocated that pamphlets cleverly recommending chewing gum be given.

Aside from the objection that most of those pseudohealth publications personify teeth and cows, much of the material contained therein is unscientific and misleading. Furthermore, the purpose of the gift is to assure a satisfying after-effect of the dental appointment. According to Thorndike,[6] the satisfier will strengthen the connection to which it is attached even though the gift "is irrelevant to the purpose in the interest of which the connection was made." Moreover, Thorndike points out that the gift may be "highly incongruous with the cravings and expectations of the person at the time" and still strengthen the connection.

It has been argued by some practitioners that it is the parents' duty to provide a trip to the ten cent store along with each visit to the dentist. The situation would be ideal if parents would provide a satisfying aftermath to the dental appointment. However, in many cases, the parents are so thoughtless that they actually give the child poor conduct patterns to follow, and the general practitioner is forced to use any measure at his command to overcome these handicaps.

Fig. 1.—Figures of Pinocchio and Jiminy Cricket, with molds.

The most popular gifts at the present time appear to be the Disney characters popularized in the animated cartoon "Snow White and the Seven Dwarfs." The rubber molds for these figures can be obtained through the American Dental Association at a reasonable price. If a large number of these figures are made, a first-grade plaster is too costly to use. To keep the cost down, it is suggested that the cheaper grades of plaster, ob-

tainable from hardware dealers, be substituted.

Rapidly gaining favor are some newer molds, suggested by the story of Pinocchio, recently popularized by an animated cartoon. (Fig. 1.)

A very popular set of rubber molds now being marketed by the American Dental Association consists of eleven newspaper comic strip characters. These "Famous Funnies" are half molds, which are easy to pour. The number of figures that can be cast from these and the Disney molds is almost unlimited, as all molds are of sturdy construction. (Fig. 2.)

Also available from the same source is a series of seven medallion-shaped rubber molds depicting famous American men. A series of molds representing people of various nationalities can be made into suitable wall plaques by embedding a wire loop in the plaster before it hardens. Statuettes of familiar domestic and wild animals can be cast from flat rubber molds, also obtainable from the American Dental Association. (Fig. 2.) All these figures have an appeal of wide age span.

Somewhat smaller figures made from molds less sturdy can be purchased for 25 cents through department stores. The choice of rubber molds available for purchase are numerous, ranging from such figures as children and nurses to the traditional soldiers.

Home-made molds can be constructed by painting a selected figure with brushable rubber or similar material now being sold by many local hardware or ten cent stores.* Reproduction of some trinkets is possible by using old impression compound or dentocoll.

Excellent lay educational models, as well as souvenirs, can be cast from a series of eight rubber molds showing a cross-section of various teeth, teeth in malocclusion and in normal occlusion, interproximal decay and an impacted lower third molar. (Fig. 3.) School teachers have expressed approval of these models because of their unlimited possibilities in promoting an interest in dental health. These models can be purchased complete, painted, and mounted in a case, from the American Dental Association at a very reasonable cost. If desired, they can be painted by the purchaser.

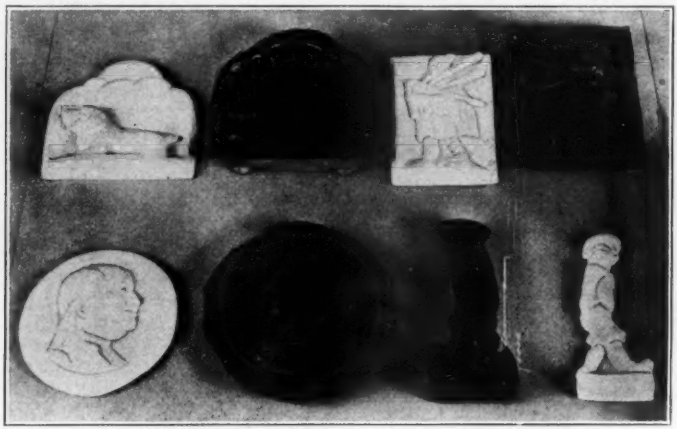

Fig. 2.—Miscellaneous plaques and figures, with molds.

It is probably unwise and unnecessary,

*Brushable rubber can be purchased from the Koehler Laboratory, Francis Building, Louisville, Ky.

in most cases, to paint the castings. If the child is allowed to paint them, his interest is greater, and the toy can be given an educational classification.

Water colors are not very satisfactory for painting the plaster figures, because the paint does not go on evenly and will not remain bright. Regulation artist's pigments mixed with turpentine are not so pleasing as when mixed with linseed oil. The best and probably cheapest paint for use on plaster figures (if a number are to be colored) is the quick-drying enamel from the ten cent store. Show card colors, also, give plaster a rich color, although a dull finish may not be so desirable as the gloss obtained with enamel.

Some practitioners encourage the child to paint the casting by allowing him to place it on the "trophy" shelf in the laboratory. This, in turn, creates a great interest in the dental office, because the child has participated to such an extent that he has even contributed to the "decorations" of the office.

Very young, shy and apprehensive children may often be approached in the dental office by eliciting interest and friendship through the construction of a simple trinket. The dental office and the laboratory may be introduced to a child by pouring a model of Snow White or the child's favorite dwarf before the dental appointment begins. After the appointment is completed, the child, of course, helps remove the casting from the mold.

Dolls appeal to little girls, and a dentist may actually obtain the help of a shy youngster in making such a toy. If two pieces of cotton roll are arranged at right angles to each other (Fig. 4) and tied in that position, something representing a doll can be made by drawing the eyes, nose and mouth with a pencil. The youngster should be induced to help in the construction by such procedures as holding her finger on the dental floss while the knot is being tied. Other cotton roll dolls are suggested in Figure 5. Lack of ingenuity and need for some experimentation on the part of the dentist or his assistant are the only limitations to the number of possible figures and animals that can be devised.

Small boys are frequently delighted to receive a boat that really sails. Here

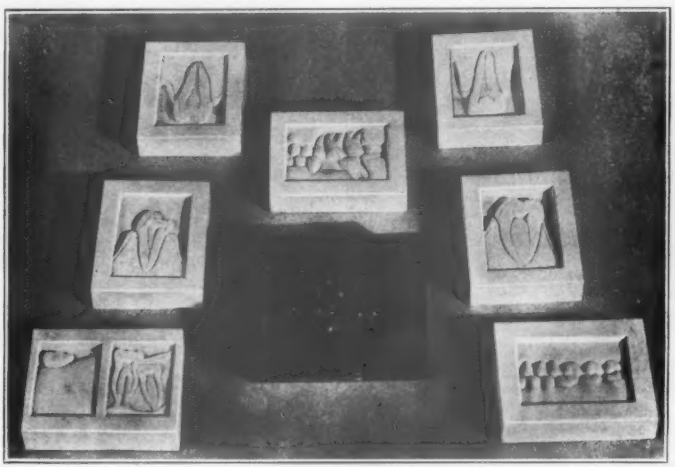

Fig. 3.—Educational models.

again is something that can be made in a moment or two before the appointment begins to impress the child that the dentist is his friend. Figure 6 shows only a few of many constructions possible with various sizes of tongue depressor blades and applicator sticks. Again care should be taken to have the boy hold implements and pieces of wood and otherwise share in the building of his souvenir. Because it dries quickly, Dupont's household cement is very satisfactory as a means of holding the deck house fast.

One may give the older boy the necessary tongue depressor blades and have him construct his own Pinocchio. (Fig. 7.)

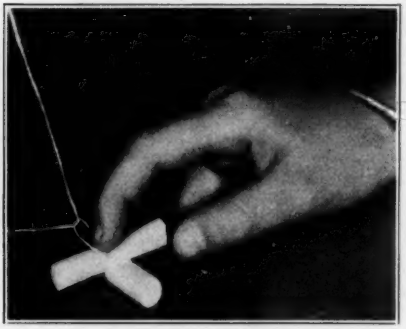

Fig. 4.—Making cotton roll doll.

In cities where noise abatement is not an issue, Donald Duck "squawkers" may be used as a souvenir. This trinket is constructed by sandwiching a celluloid strip between two pieces of tongue depressor blades in such a manner as to allow a small space between the free ends of the blade in which the celluloid strip may vibrate. The squawker is placed between the lips and the breath is exhaled, as in humming through a comb and tissue paper instrument. (Fig 8.)

In good practices, the child's first appointment consists of an examination, roentgenograms, prophylaxis and toothbrushing instruction. At the conclusion of the appointment, the usual procedure is to present the new brush to the child. In order to make the gift more personal and thus more appealing, some practitioners write the child's name on the handle of the toothbrush with celluloid ink (Stafford) mixed with an equal part of acetone (Fig. 9.) Another clever idea employed in some offices is to present inexpensive composition drinking-cups. The child's name, a cartoon and the date of the next series of appointments can be placed on the container in celluloid ink. The container is then used at each sitting during the current series of appointments. At the last sitting, the child is allowed to take his own cup home. The same idea can be carried out by using a stone to grind the child's name and date of return into a small drinking glass.

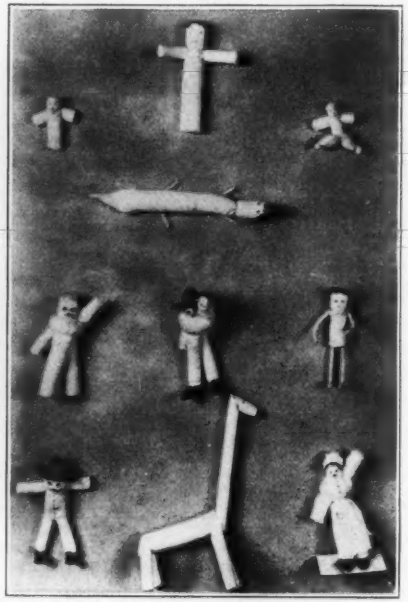

Fig. 5.—Cotton roll figures.

A drawing on the back of a child's left hand is an excellent reminder that a new filling on the left side of the jaw must not be used for an hour or two after it has been placed. When no skin

lesion is present, an indelible pencil can be used to draw a simple picture on the hand. The technic is practical and receives no objection from anybody except school teachers, who find that such children are no longer interested in the hygienic measure of washing the hands.

Fig. 5.—Boats made from tongue depressors and applicator sticks.

Numerous other means can be used to intrigue the child patient and make the dental office an attractive place. One clever subterfuge depends on concealing an electric bell in the dental unit, which is operated by a switch concealed under the mat at the base of the chair. When a child expectorates, the bell rings only when the center of the cuspidor is hit, because the observing operator closes the switch only at the proper moment. The trick fosters an effort on the child's part to do exactly as the dentist says. It helps keep the office clean, and the mystery of the bell creates a greater interest in the dental office environment. Obviously, the trick is instrumental in enlarging the practice of dentistry for children, because playmates soon learn of these unusual happenings. The dentist who uses such tactics, however, will have to be ready to receive "investigating committees."

In some offices, the "penny in the boxes" trick is used to interest children. The child is given a penny and asked to make an identifying mark on it, as well as to remember the date that it was minted. In the operator's pocket are two boxes, one within the other and each bound with string or rubber bands. One end of each box has an opening large enough to allow a metal shoot for the penny to be inserted. The operator slides the penny down the shoot, removes the shoot, extracts the trick boxes from his pocket and tells the child to unwrap them. Of course, amazement is expressed at finding the marked penny inside the two well-wrapped boxes.

Gifts of empty bur boxes, old burs and instruments often please the young patient. Everlasting friendship can be fostered between the dentist and his young patients by his saving paper match covers for those patients interested in collecting such items.

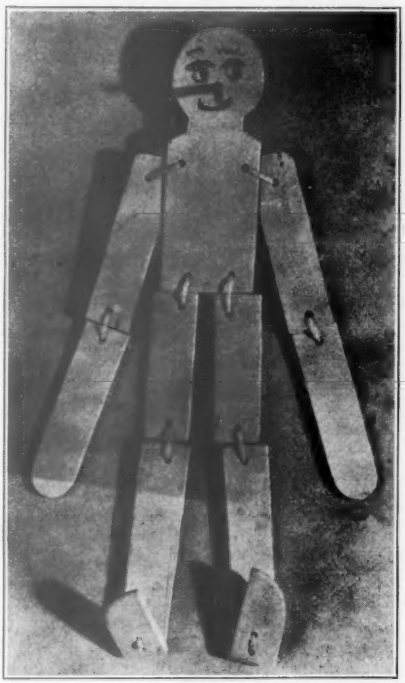

Fig. 7.—Figure, made by older boy, of tongue depressors.

April Fool's Day is the signal for spe-

cial efforts toward fooling the children. Everybody has fun when ice cream is substituted for plaster as an impression material or when coca cola is used for a mouth spray. On the other hand, April first may well be the excuse for "pulling old chestnuts" like fastening coins to the floor.

Pediatricians, as well as dentists, in the effort to assure a satisfying after-effect, occasionally make the error of presenting children with a stick of gum or a lollipop. In view of the fact that much

Fig. 8.—Child with Donald Duck squawker, made of a strip of celluloid between two pieces of tongue depressor.

evidence in condemnation of the excessive use of carbohydrates is being continually collected, it would seem that such gifts are not ideal.[7-8]

Orthodontists, no doubt, would be hard pressed to find a new gift for a patient whom he treats periodically for several years. For that and other reasons, there is little cause for the child to receive a gift in his office, yet he may well profit by catering to the tastes of his young patients, with children's books and magazines in the waiting room, a radio for reception of certain programs of interest, tricks and other interesting breaks in the monotony of visiting the dentist.

The foregoing discussion presents only a few ideas that the general practitioner may employ to make the dental office environment attractive to children, to interest the shy and apprehensive patient, to improve the behavior of children, to increase the number of children in his practice and to transform a dental visit into an exciting event.

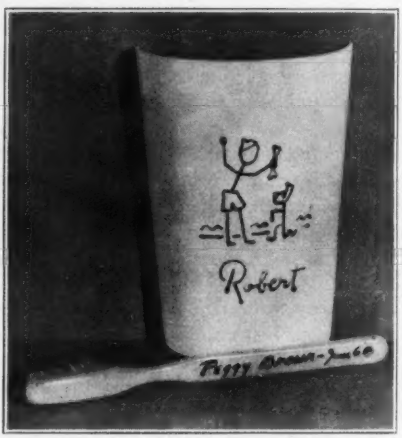

Fig. 9.—Paper cup and toothbrush bearing name of patient.

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The individual dentists responsible for some of the ideas incorporated in this paper are: R. E. Barnes, Cleveland, Ohio; J. D. Burkes, Knoxville, Tenn.; M. Davis, Louisville, Ky.; K. A. Easlick, Ann Arbor, Mich.; J. W. Matthews, Nashville, Tenn.; S. R. Meaker, Chattanooga, Tenn., and C. E. Mathis, Union City, Tenn.

SILICOSIS: A POTENTIAL HAZARD IN DENTAL LABORATORIES

By LEON R. KRAMER,* D.D.S., Topeka, Kans.

TO the many health hazards associated with the practice of dentistry is added silicosis. In a review of the literature on silicosis, two articles were found that should be of interest to the dental profession. A fatal case of silicotuberculosis in a worker who had been engaged in a dental laboratory for nineteen years has recently been reported,[1] and the findings of a survey that is being made on the silica content of "pummy," a substitute for pumice stone,[2] were also published. Pumice is used in many operations in dentistry. The more hazardous of these seem to be its use in the polishing of metal appliances and denture materials.

The pumice used for this operation consists principally of combined silica in the form of silicates and would not under normal conditions constitute a hazardous exposure. It was discovered, however, in the investigation that followed, that the abrasive used by the laboratory was a less expensive substitute, but was sold as "pummy," and contained 48 per cent free silica. The laboratory had not been informed of the substitution.

Fifty-three laboratories are being surveyed, in twelve of which an analysis of the abrasive used has been made. Only four of the twelve samples were found to be pumice. The other eight consisted of from 70 to 90 per cent free silica, which is essentially ground quartz.

Since silicosis even in its milder forms is believed to create a predisposition to other respiratory diseases, notably tuberculosis, dentists and purchasing agents of dental laboratories should be sure that they are not receiving and using the more toxic ground quartz as a substitute for pumice.

*Director, Division of Dental Hygiene, Kansas State Board of Health.

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PROXIMAL IMMUNITY

By TRIM HOUSTON, D.D.S., Corsicana, Texas

THE following recital illustrates what can be done—under ideal conditions—especially in the matter of proximal decays.

Of 128 children entering an orphanage at 6 years or less of age and remaining until 18 years of age, only one was found to have developed proximal decay. The one, who was subnormal, both mentally and physically, and syphilitic, was found to have a proximal defect on the mesial surface of each of the lower first molars. It should hardly be necessary to say that not one permanent tooth has been lost from decay nor has a nerve been endangered, much less destroyed, in any of these 128 children. This means two proximal cavities in 3,584 teeth at 18 years of age.

Now, all this did not just happen. This is how it was brought about.

These children are the wards of a fraternal order, whose desire and every effort is to see that they have all they need —not necessarily all they want. They are excellently housed, clothed and fed. Meat, usually fresh, is given them once daily; fruits and vegetables, fresh when possible; plenty of whole sweet milk; about one-third the average of sugar, etc.; with no sweets nor soft drinks between meals. The greater part of their time, when they are not eating, sleeping or studying, is spent outdoors. The general medical man and the eye, ear, nose and throat specialist care for them, from their angles, as thoroughly and carefully as I do, or can do.

Their mouths are examined by me at the home, two, three or four times yearly, as indicated, each case being a law unto itself. Every pit, fissure and depression is carefully explored for any break in its continuity. The proximal surfaces, both lingual and buccal, are gone over meticulously. In case the explorer catches, the child is instructed to come to the office during the month.

Nothing is left to chance—there is no waiting to see what will happen. In 65 per cent or more of these cases, there is no visual evidence of actual decay, but again we take no chances. All the attention is given by me—nothing is delegated to someone else.

The children are supposed to brush their teeth three times daily, with a medium bristled youth's or child's size brush, water and salt—no dentifrices, on my orders. In case there is evidence on examination that a child is neglectful, I report his case to his matron. If he is still neglectful, I report the matron to the superintendent. Since the superintendent does not care to be bothered with such routine affairs and the matron does not care to lose her job, one reporting is usually sufficient. From then on, that youngster has a hard time trying to shirk this particular duty to himself.

To recapitulate: We have regular, meticulous inspections, with immediate care for all possible defects; regular care on the child's part, with no dentifrices; a well-balanced, wholesome diet, with a minimum of sugar—no sweets or soft drinks between meals; outdoor exercise and fresh air, and every attention needed at the hands of the physician and eye, ear, nose and throat specialist.

The results: The gums are pink and firm, clean and healthy. The saliva is clear, free flowing and normal in constituency. The luster of the tooth increases. Mottling of the enamel, in some cases, disappears altogether. The arches have broadened and rounded. There is only one case of caries as against 127 with no proximal decay.

COUNCIL ON DENTAL THERAPEUTICS

HEALTH HAZARDS IN ACETANILIDE-CONTAINING NOSTRUMS AND MIXTURES

By PAUL J. HANZLIK, M.D., San Francisco, Calif.

THE following article, prepared by Prof. Paul J. Hanzlik, vice-chairman of the Council, has been adopted by the Council and authorized for publication as one in the series of articles on pharmacology and therapeutics.

Elsewhere in THE JOURNAL (27:1137, July 1940) will be found a summary of actions by the Food and Drug Administration on preparations containing acetanilide and related substances. Not included in this summary was the résumé of the lengthy account of the consent decree of condemnation and forfeiture in the Bromo-Seltzer case (N.J. No. 81, May 1940). The members of the profession will also note that among the requirements of the new Food, Drug and Cosmetic Act is the declaration of the qualitative composition of drugs on the package label. This and certain other features of the new Act were brought out in another article in THE JOURNAL (27:80, January 1940).

In connection with a study of the effects of headache remedies and pain relievers, recent articles (*J.A.M.A.*, 113: 446, August 5, 1939; 114:272, January 20, 1940) on bromide intoxication are of interest.

HAROLD L. HANSEN, *Secretary.*

INTRODUCTION

ACETANILIDE belongs to that potent group of medicinal agents known as coal-tar derivatives. Closely related drugs are acetophenetidin and aminopyrine and their derivatives. These drugs are widely exploited directly to the public, and indirectly through the medical and dental professions. The pure compounds are official in the United States Pharmacopoeia[1] and several preparations containing them, in the National Formulary.[2] Others are accepted in New and Nonofficial Remedies[3] and Accepted Dental Remedies.[4] While the pure compounds are prescribed by physicians in powder or tablet form, the bulk is distributed as modified official mixtures and in mixtures with other compounds. These mixtures offer great opportunities for counter-prescribing in drug stores and at soda fountains and bars, ready dispensing by practicing physicians and domestic medication with trademarked or proprietary products. Frequently, the presence of these coal-tar compounds in mixtures is not revealed to physicians or the public. Labels, advertisements and radio announcements are conspicuously silent on composition. The public is asked to swallow all—drugs and promises—regardless of the outcome. But qualified pharmacologists and physicians are not misled by commercialized propaganda. They know that there is nothing original in composition, claims or uses of these widely exploited drugs. Unfortunately, people do not realize the insidiousness and deceptiveness of such commercial exploitation—that it is both uneconomical and hazardous for the public itself. Even qualified scientists may be misled by research results with these mixtures. In recent times particularly, there have been published several experimental re-

From the Department of Pharmacology, Stanford University School of Medicine.

ports in which the results may be questioned. Inadequate criteria, choice of the wrong animal and lack of appreciation of dietary habits and gastrointestinal conditions leave much to be desired in these reports. Premature transfer to man of results of questionable validity has provided the means for advertising claims which exaggerate or misrepresent known effects in man. A careful consideration of these various matters with reference to acetanilide having brought to light the unsatisfactory and deceptive character of the claims, a report on these, it is believed, will be of general interest.

ACETANILIDE-CONTAINING NOSTRUMS AND MIXTURES

Among the most widely exploited acetanilide-containing products is Bromo-Seltzer, which is advertised in some professional journals and in many magazines. In the same category are many antiheadache and antineuralgia powders, wafers and tablets. For the professions, and to some extent for the laity, there are many (at least thirty) so-called "analgesic-hypnotic" mixtures dispensed in tablets, capsules or pills, containing acetanilide, acetophenetidin or antipyrine as the analgesic constituent and marketed under bizarre and misleading names. In "Nostrums and Quackery and Pseudomedicine,"[5] there are listed sixty-one nostrums more than 75 per cent of which contain acetanilide. The remainder contain acetophenetidin. Generally, these drugs are present with one or two other active drugs. These nostrums are recommended for a host of miscellaneous complaints, for the most part colds and grip and common aches and pains, but including rheumatism, asthma and hayfever.

The compound powder of acetanilide, official in the National Formulary,[2] has been the common basis for composition of numerous proprietary acetanilide mixtures. Sometimes, it has been used as such and exploited as a new discovery. Again, slight modifications in content of ingredients or use of substitutes or added constituents have been introduced so as to exploit claims of alleged originality, as in the miscellaneous nostrums referred to. The compound powder of acetanilide (N.F.) contains acetanilide, 70 per cent; caffeine, 10 per cent, and sodium bicarbonate, 20 per cent. Bromo-Seltzer is reported to contain acetanilide, caffeine, sodium bromide, sodium bicarbonate and citric acid,* the proportions of the ingredients not being given. In Bromo-Seltzer, acetanilide is claimed to be "synergistically combined with caffeine and bromides for maximum analgesia with minimum dosage." Generally, however, it is believed that caffeine and acetanilide are pharmacologic antagonists and not synergists, so that caffeine, as a central stimulant, might act as a corrective for acetanilide, as a central depressant. Theoretically, bromide might act synergistically with acetanilide although bromide is a hypnotic, whereas acetanilide is an antipyretic in febrile states, the central depressant action being too weak for practical use. Moreover, because bromide is a relatively weak hypnotic, dosage must be comparatively high, and, therefore, the content of bromide in Bromo-Seltzer, if low, is of no intrinsic merit. But if there should be potentiation of acetanilide effects by the small amount of bromide, the result might be important in toxic rather than therapeutic effects.

The miscellaneous nostrums referred to contain, in addition to acetanilide, such potent drugs as codeine, quinine, aloin, podophyllum, acetylsalicylic acid, caffeine, cinchonine, potassium bromide, camphor, magnesium sulfate, strychnine, phenyl salicylate, phenolphthalein, jalap, salicylic acid, sodium salicylate, aconite, terpin hydrate, iodide, lobelia and antipyrine. As for other ingredients, many

*The formula of Bromo-Seltzer was changed during the last months of 1939, especially the quantitative composition. (Personal communication from Theodore G. Klumpp, Chief, Food and Drug Administration, U. S. Department of Agriculture, Washington, D. C.)

of the nostrums are practically similar to Bromo-Seltzer as regards composition. Several of the products cause catharsis, which apparently may be the condition resulting in one kind of cyanosis. Some simpler mixtures contain only acetanilide and sodium bicarbonate, the latter allegedly to promote solubility of the former. All told, therefore, there may be well over 100 proprietary products or nostrums, and perhaps 200, when included are the official, accepted, druggists' specialty, imported and extemporaneous or locally originated products and mixtures which contain acetanilide and are distributed throughout the country.

There are still other mixtures of acetanilide on the market, the composition of which is not known or fluctuates from time to time. However, acetanilide is apt to be the most potent, and may also be the most objectionable, constituent, since it has decided potentialities for toxic and undesirable effects. A consideration of other constituents might prove enlightening, if they were known, as they are often assumed to be harmless or unobjectionable. Even if these adjuvants are unessential therapeutically, they may be objectionable only when mixed with acetanilide. The possible reinforcing, potentiating, additive and even antagonistic actions of the other constituents in acetanilide mixtures have never been adequately investigated. Some may create new conditions which affect the pharmacologic actions of acetanilide; others may be affected by conditions and influence the actions. For instance, the use of substances, drugs and diets containing sulfur and cathartic salts, and of catharsis, in general, are warned against in medication with coal-tar derivatives on account of the production of certain blood pigments and cyanosis. Unexplored possibilities for important toxic effects, only recently recognized, should enjoin caution against the hasty or indiscriminate use of these products.

At all events, enormous quantities of acetanilide are taken annually by the population; not to mention the rather large quantities of chemically related or similarly acting drugs taken oftentimes with acetanilide. The pharmaceutic industry boasts of disposing of tons of acetanilide annually in the United States. Clearly, here is a problem in continuous mass medication of great proportions which is worth some consideration from the standpoint of individual and public health. Such consideration might well bring out many things not yet understood, but of prime importance for the general actions and side actions of these agents.

PROBLEM OF CHRONIC INTOXICATION

From the experimental standpoint, the problem of mass medication with acetanilide is to be regarded in the light of chronic intoxication rather than acute toxicity, or sudden outbursts of poisoning with dramatic symptoms. In many cases, these nostrums are used as household remedies, being taken for years and continued by succeeding generations in the same family. Cases of chronic acetanilide poisoning are on record in which the drug was taken steadily for fifteen years, about one-fourth the average span of life. Children are medicated as often as adults. Habituation develops to such astounding proportions that a business man, or an executive or a teacher may not begin his day's work without a pill or tablet. Again, the indulgence is periodic, but nevertheless frequent enough for chronic effects. In many individuals, the habit of taking these nostrums becomes established, like the liquor habit in others. Acute poisoning is comparatively uncommon, except in children, although suicides from swallowing several hundred tablets are reported in large cities. Villages, small towns and rural communities are so thoroughly exploited with these nostrums that nothing better in medical service may be known for a cold or "flu" or an ache. Cases of violent poisoning or death are not common in these communities because the people

know in a general way, and frequently on advice of druggists, peddlers or detail men, the dosage that "helps." But the laity, and even practitioners, are not generally aware of the insidious undermining of health, with reduction in resistance, which may occur as the result of frequent or continued drugging. Clinical results or statistics are not available for assessment of this phase of medication. Therefore, resort must be had to suitable experimental animals, which must be used under properly controlled conditions. Since desirable or exact conditions for proper experimentation with acetanilide are not appreciated by some investigators who have undertaken studies of chronic intoxication, this report considers methods as well as results in assessing the value of experimental investigations for clinical applications.

The acute effects are important chiefly in cases of accidental or suicidal poisoning. Since these are not of primary concern in this report, they are not considered. Collapse effects and blood changes in serious, near fatal or fatal cases, and in sensitive persons, are to be expected, and would be treated accordingly. The blood changes which develop in chronic cases probably originate in the same way as in the acute, but are more significant for general and sustained tissue injury. Recovery may occur from a single attack of poisoning, but repeated insults to injury of the hematopoietic organs will produce lasting or chronic effects, with serious consequences.

CHRONIC EFFECTS

The general effects to be expected early in continued administration for long periods are non-specific and similar to those from a number of drugs and poisons. These are manifested by anorexia and reduced food intake, impaired nutrition, loss of body weight, stunting of growth in the young, anemia, diminished resistance to intercurrent infections, colds and the like, gastrointestinal disturbances, fatigue and diminished muscular power. In man, there are lassitude, dizziness, dyspnea on exertion, nervous irritability, apathy, dullness, itching of the skin, sighing, yawning, somnolence, disinterestedness in work and environment, headaches, aching joints and muscular pains and other subjective symptoms, according to individual character. These subjective symptoms are not reproducible in lower animals. They are fundamentally the result of diminished food intake resulting from impairment of the appetite. The consequent anemia and impaired nutrition are enough to account for many late developments.

More specific changes resulting from the continued use of acetanilide are secondary anemia with blood destruction, cyanosis, methemoglobin or sulfhemoglobin formation, dark-colored urine, coldness of extremities, blood dilution, circulatory depression, visceral injuries (kidney, liver and heart), albuminuria, icterus, subnormal temperature, dyspnea, cardiac irregularities and collapse. These changes have been described in both animals and human beings. In addition, in man, there are craving, addiction, depravity, abstinence symptoms, serious blood destruction, leukopenia, pernicious-like anisocytosis, enlargement of the spleen, scotomata, marked cyanosis of the face, eyelids, lips, tongue and fingers, coldness of extremities, skin rashes, folliculitis, emaciation, general incapacity, frequent colds, weak and rapid pulse, circulatory collapse, delirium and death from pneumonia or other intercurrent disease.

A number of investigations have been concerned with the possible nature of the more specific signs and symptoms of acetanilide intoxication, especially the blood and hemoglobin changes. The question of addiction has also been tested experimentally. The dosage necessary for producing certain late effects has sometimes been so large in animals as to arouse suspicions of claims for injuriousness of the drug in man. The failure to cause manifestations of ill health or poisoning,

including blood and hemoglobin changes, in rodents given very large doses has been used by manufacturers to make unwarranted claims of safeness for human beings. The data of these investigations may now be considered, beginning with a consideration of the cyanosis and hemoglobin changes.

CYANOSIS AND HEMOGLOBIN CHANGES

The cyanosis of acetanilide poisoning has long been recognized although it occurs irregularly and variably. The darkness of the lips and tongue is sometimes out of proportion to the symptoms, as though some unusual pigmentary change was present in the blood. Methemoglobin is first to be thought of, but this pigment is brown (chocolate-color). The mucosae and urine possess a brownish tint in frank methemoglobinemia. Dosage of acetanilide is not necessarily a determining factor in the variability of the cyanosis. The blood discoloration varies with species, individuals, metabolism, and central nervous sensitivity.[6] The individual variation is not difficult to understand in the light of recent emphasis on the importance of the gastrointestinal state and diet for certain blood pigment changes. In other words, the cyanosis may be due to some other pigment besides methemoglobin. In acute experiments, acetanilide is not a powerful direct circulatory depressant, but functional impairment can be mediated through other actions. The depression may occur indirectly as a result of the impaired respiratory function of the blood due to slowly reversible or irreversible changes in hemoglobin.

ACETANILIDE, A POOR METHEMOGLOBINIZER

Acetanilide does not readily produce methemoglobin either *in vitro* or *in vivo*. Its methemoglobinizing efficiency is not comparable with that of the nitrite group (most), phenylhydrazine and methylene blue (least). Even these efficient methemoglobinizers act better in the living organism than directly on blood *in vitro*. In order that satisfactory results may be obtained *in vitro*, certain conditions of the blood must be present. For instance, the nitrite action on hemoglobin is largely a function of the pH; i.e., methemoglobin producing efficiency increases with increasing acidity up to pH 5.0, when the conversion of hemoglobin is complete, so that 1 mol. of nitrite reacts with 1 mol. of hemoglobin.[7] At pH 7.0, mols. of nitrite are necessary for 1 mol. of hemoglobin, and true alkalinity allows only minute changes. According to a recent report by Michel, Bernheim and Bernheim,[8] acetanilide can be slowly hydrolyzed by various tissues (weakest by blood and muscles, strongest by liver and kidney) *in vitro* into acetic acid and aniline, most efficiently at an alkalinity of pH 8.0. Aniline is unable to convert the hemoglobin directly into methemoglobin, but since the conversion can be mediated through liver, even after boiling, a living ferment is not necessary. None of these favorable conditions for nitrite and acetanilide *in vitro* apply during life. Therefore, normal conditions of the blood, and presumably the tissues, are unfavorable to direct methemoglobin formation from even the choicest agent; namely, nitrite. There is no good reason to believe that acetanilide is stronger than nitrite, but this drug may be changed to other products, or produce abnormal states, which might favor the transformation of hemoglobin to methemoglobin. Agglutination, hemolysis and excess of carbon dioxide all favor methemoglobinization. Even in susceptible species, one of these conditions may be necessary for successful demonstration of methemoglobin from such an agent as methylene blue. Anything which favors erythrocytic (cell-surface) permeability apparently promotes this pigmentary change. In fact, hemolysis alone, without the addition of any drug or poison to blood, and general postmortem changes without medication or poisoning result in methemoglobin formation. Drugs like acetanilide may catalyze the transformation of oxyhemoglobin to

methemoglobin. No wonder that reports on acetanilide added to blood or administered to animals, and in human poisoning cases, have given equivocal or confusing results as to methemoglobin. The time of drawing blood for an examination, before or after hemolytic and postmortem changes, is all important in determining whether acetanilide has produced methemoglobin during life, but details of this kind are frequently lacking in many reports.

In human cases of cyanosis from taking acetanilide, the evidence from blood studies is often more satisfactory than in experimental animals fatally poisoned. Species differences are now known. Rodents are poor methemoglobin formers, while other mammals (cats and dogs, especially), including man, and birds are better, this fact rendering a proper choice of animal a prime requisite of acceptable scientific investigation.[9] But blood *in vitro* of the resistant species may react quite as readily as that of the less resistant. The diet of animals may be a factor in species differences, since carnivora, it has been said, are more efficient reactors than herbivora; and man, being omnivorous, stands between the two.

Difficulties of demonstrating a direct relationship of cause and effect in acetanilide methemoglobinemia were met with by Ellinger[10] (1920), who postulated an indirect mechanism. Ellinger claimed that the formation of methemoglobin from acetanilide and derivatives depended on an intermediate product; namely, acetylphenylhydroxylamine. This product, he further claimed, was formed by contact of acetanilide with the tissues. It would act efficiently because all hydroxylamines are strong methemoglobinizers. Aceto-o-toluidine and acetophenetidine also acted indirectly as methemoglobinizers. Recently, however, Michel, Bernheim and Bernheim[8] have claimed that tissues change acetanilide to acetic aid and aniline. Kobert[11] remarks on the relative ease with which methemoglobin is produced in animals, but the old work, which he quotes, is not worth while discussing here, because the methods of those times hardly compare in accuracy with present day methods. The older effects were shown in dogs, which are suitable experimental animals for methemoglobin studies. In contrast with this is the modern review by Rhode,[6] which lays emphasis on difficulties and complications met in attempts to account fully for the blood pigment changes after acetanilide.

Nearly twenty years ago, McEllroy[12] demonstrated methemoglobin in a case of human poisoning from Bromo-Seltzer, attributing this to the acetanilide present in this nostrum. The methemoglobin was demonstrated by spectroscopic changes only after laking the blood, which showed a reduction in oxygen capacity, a nonspecific change. The latter, however, correlated with the spectrum. Later, Kruse and McEllroy,[13] in a study of the methemoglobinemia of acetanilide, pointed to certain difficulties commonly overlooked in experimental research and used criteria superior to those employed up to that time. These authors found that rabbits gave misleading results, dogs being far more satisfactory. Whereas gastric doses of from 0.1 to 0.3 gm. of acetanilide per kilogram of dog readily produced methemogloblin, doses of from 0.3 to 0.5 gm. per kilogram of rabbit failed. Their criteria of methemoglobin formation were reduction in oxygen capacity of the blood, typical spectrum changes, the dark color of blood, cyanosis and persistent blood dilution. The reduction in oxygen capacity was out of proportion to the amount of hemoglobin present, and apparently the result of the blood dilution. No methemoglobin was demonstrated after twenty-four hours, but blood dilution persisted, especially after large doses. A rather rapid reconversion of methemoglobin to hemoglobin was observed. The reconversion and hydremic phenomena were unexplained, but they are really uncontrollable vari-

ables which shed a light on the irregularity of methemoglobin formation and cyanosis. This was not originally appreciated, but certain facts are now known which provide a reasonable explanation of the changes.

It is known from the work of Barbour and Hermann[14] that coal-tar antipyretics such as antipyrine, to which acetanilide belongs, produce hyperglycemia and blood concentration in the dog, which are naturally accompanied by blood dilution. An increase in blood sugar promotes conversion of methemoglobin to hemoglobin, according to Brooks.[15] Now, since these are all variable phenomena, failure to demonstrate methemoglobin, even in susceptible species, is not surprising in the face of an apparently effective automatic conversion mechanism such as hyperglycemia. But if the hyperglycemia should fail or be mild, demonstrable methemoglobinemia would be expected. When asphyxia occurs, hyperglycemia may be marked, and other products besides sugar may be present, and thus an automatic means of converting the methemoglobin is brought into action. Conversely, a hypoglycemia would theoretically favor methemoglobin formation; and so does alcohol (in aniline-poisoned cats), according to a recent report by Heubner and Schmedtke.[16] If cyanosis persists, and since methemoglobinemia is apparently impossible or doubtful in the presence of hyperglycemia, the darkening of the blood must be due to some other pigment, such as sulfhemoglobin, or coal-tar oxidation products. These have been demonstrated in acetophenetidin and acetanilide poisoning. Actually, experiments with acetanilide have not been made to permit a definite assertion of the cycle of blood phenomena just detailed. However, it would be short of miraculous to find one member of the same coal-tar group, but not another closely related member, producing these changes. The correlation of changes here suggested indicates the need for further research into phases of acetanilide action not yet understood because they have been overlooked.

Some of these factors may have been responsible for the failure to demonstrate methemoglobin formation after the rather small doses of acetanilide in dogs and rabbits reported by Young and Wilson.[17] The dogs were injected apparently with only about 1 to 1.6 gm. of acetanilide in acute experiments. The rabbits were given about 3 gm. The spectroscope and a colorimetric method were used for detection of methemoglobin. Probably, failure to medicate long enough and the use of unsatisfactory methods were as much responsible for the negative results as a possible hyperglycemia accompanying the reported cyanosis. Young and Wilson did demonstrate a toxic action on the heart indicated by a change in the conduction mechanism, and also an anemia. These authors ascribed the cyanosis to paraminophenol, which they claimed to have demonstrated in the blood of dogs. However, according to Rhode's review[6] of the subject, oxidation of acetanilide in carnivora (dogs) results in the ortho position for the amino group and not the para position as in herbivora, and the acetyl group in carnivora is not eliminated but oxidized, so that, in carnivora, the oxidation product is ortho-oxyphenylcarbaminic acid. In man, the oxidation product is para-acetylaminophenol conjugated with sulfuric or glycuronic acid. Apparently, the latter oxidation product occurs in herbivora. Accordingly, it seems that the fate of acetanilide probably varies with the species, although present information on the subject is in a controversial state. Cyanosis of the face, lips and tongue was outstanding in ten patients taking acetanilide habitually, as reported by Lundsteen, Meulengracht and Rischel.[18] Several patients used from 0.3 to 4.5 gm. daily for fifteen years. These authors attributed the cyanosis to paraminophenol derivatives, but their conclusion may be incorrect. Other signs present were emaciation and anemia. The authors pointed out that addiction to acetanilide initiates

a vicious cycle of prime importance; that is, the drug is commonly taken for relief of malaise and headache, but later only aggravates these symptoms.

Fisher[19] reported cyanosis and other symptoms in a patient taking daily 8.4 gm. of acetanilide in Bromo-Seltzer and Anacin tablets. He assumed that the cyanosis was due to methemoglobinemia. Previously, the same patient had been taking daily 3.78 to 7.56 gm. of acetanilide, the periods of medication not being indicated. Even as single doses, such quantities of acetanilide would be enormous, and in many healthy and strong persons, acute toxicity would result. They do demonstrate the magnitude of irresponsible medication resulting inevitably in addiction and harm. Deep cyanosis in a female patient was ascribed by Raven[20] to demonstrable methemoglobin, due to poisoning by an undetermined quantity of a nostrum; namely, "antikamnia," which is said to contain 70 per cent acetanilide. Other changes were hematuria and pyrexia.

(To be continued)

PRESCRIBING SUGGESTIONS

THE rational use of drugs and chemicals is an essential part of dental practice. Over a period of years, the Council has issued numerous reports designed to aid the dentist in the selection of drugs and chemicals of demonstrated usefulness. Many of these are National Formulary and U. S. Pharmacopoeia substances, listed and described in Accepted Dental Remedies, 6th edition. In order that the dental professional may use acceptable and official products, and to the best advantage, the following formulas have been suggested.

The Council appreciates the cooperation of George C. Schicks, assistant dean of Rutgers University and chairman of the Committee on Dental Pharmacy of the American Pharmaceutical Association, in the preparation of the formulas.

SERIES VIII

CAVITY LINING

a)

℞	Metric Approximate	Apoth. Equivalents
Resinae	2.0 gm.	ʒ ss
Chloroformi	30.0 cc.	℥ i

Misce.

Sig.: For dentists, use as a varnish or cavity lining.

Note: Preserve in well-closed containers. The addition of 0.6 gm. (10 grains) of sodium bicarbonate will neutralize the acids from the rosin. Use clear solution if sodium bicarbonate is added. Do not filter.

b)

℞	Metric Approximate	Apoth. Equivalents
Gum Copal	1.5 gm.	gr. xxiii
Chloroform	30.0 cc.	℥ i

Note: Powder the gum copal and place in small flask. Add the chloroform and shake occasionally during twenty-four hours or more. Filter off the liquid and add chloroform to make 30 cc., or 1 ounce. If turbid, shake with 2 gm. of purified talc and filter. The solution is approximately 3 per cent strength. Discard the gummy residue in the flask.

ANTISIALAGOGUE

c)

℞	Metric Approximate	Apoth. Equivalents
Tab. Atropinae Sulfatis	0.0005 gm.	1/120 gr.

*D. T. D. No. XII

Sig.: One every 3 hours as directed.
Note: Each tablet contains 1/120 of atropine sulfate.
Suppresses flow of saliva.
Overcomes the depressant effects of morphine on respiration.
Dryness in the throat is one of the first toxic symptoms.
*Dentur tales doses: Of such doses, give twelve.

c)

℞	Metric Approximate	Apoth. Equivalents
Tinctura Belladonnae	15.0 cc.	℥ ss

Sig.: 12 drops as directed.
Note: 0.75 cc. (12 minims) representing approximately 0.2 mg. (one three-hundredths grain) of mydriatic alkaloids. 10-12 drops (average dose) should dry up the salivary secretions appreciably in 2½ to 3 hours. Dryness in the throat is one of the first toxic symptoms.

DISINFECTING FLUID—COLD PROCESS

d)

℞	Metric Approximate	Apoth. Equivalents
Solution of Formaldehyde	266.0 cc.	℥ viiiss
Sodium Borate	30.0 gm.	℥ i
Distilled Water q.s. ad.	480.0 cc.	℥ xvi

M.
Sig.: Disinfecting fluid for instruments.
Note: Sterilization by heat is preferable. Does not rust instruments. Hypodermic needles should be rinsed inside and outside before using solution. None of the common solutions for this purpose will penetrate the lumen of the needle.

ACCEPTED DENTAL REMEDIES

The Council on Dental Therapeutics of the American Dental Association announces the inclusion of the following articles in the list of Accepted Dental Remedies.

DENTIFRICES*

Taylor's Tooth Powder: Composition: See Graver's Tooth Powder (A.D.R., Ed. 6, p. 116).
Manufactured by C. J. Graver & Co., Cleveland, Ohio. Distributed by Wm. Taylor & Son Co., Cleveland, Ohio.

Hopkins Tooth Powder: Composition: See Graver's Tooth Powder (A.D.R., Ed. 6, p. 116).
Manufactured by C. J. Graver & Co., Cleveland, Ohio. Distributed by Read Drug and Chemical Co., Baltimore, Md.

Gold's Tooth Paste: Composition: See Milkident Dental Cream (A.D.R., Ed. 6, p. 118).
Manufactured by The Trade Laboratories, Inc., Newark, N. J. Distributed by Gold's Drug Stores, Jersey City, N. J.

Mabley's Dental Cream: Composition: See Zanol Tooth Paste (A.D.R., Ed. 6, p. 121).
Manufactured by American Products Co., Cincinnati, Ohio. Distributed by Mabley & Carew, Cincinnati, Ohio.

Potassium-Sodium Carbonate Mixture (Bisbee): Composition: Potassium carbonate, 12.5 gm.; sodium carbonate, hydrous, 2.5 gm.; glycerin, q.s.
ACTIONS AND USES: For the treatment of hypersensitive dentin.
Manufactured by McDonald Pharmacal Co., St. Paul, Minn. Distributed by R. F. Bisbee, St. Paul, Minn.

Admission of an article to the list of Accepted Dental Remedies does not imply a recommendation. Information regarding the rules and work of the Council will be sent on request.

HAROLD L. HANSEN, *Secretary.*

*A.D.R., Ed. 6, p. 111.

COMMITTEE ON LEGISLATION

RESPONSIBILITY OF THE DENTIST IN THE SELECTION AND ADMINISTRATION OF ANESTHETICS

By LESLIE CHILDS, Indianapolis, Ind.

As a general rule, a dentist will assume full and sole responsibility in the selection and administration of anesthetics in his treatment of patients; for, barring the case of an exceptional patient who may have medical knowledge or training, the judgment and advice of the dentist will rarely be questioned on this point.

Consequently, if injury to the patient results therefrom, the question of the dentist's liability will usually be one of fact involving points of practice, which, in turn, will be decided upon expert testimony. Perforce, the verdict of a jury thereon will rarely be disturbed when supported by competent evidence. And, as an example of judicial reasoning in a case of this kind, Zulinsky *et al.* vs. Greenblat, 14 N.J.M. 345,184 Atl. 806, comes to hand.

FACTS IN THE CASE

Here, the plaintiff, a boy, aged 9, suffering from toothache, was taken by his mother to the office of the defendant for treatment. At this time, the plaintiff's mother testified that the gum area around the tooth was "flaming red."

From the record, the defendant administered an anesthetic by inserting a needle into the plaintiff's gum on both sides of the aching tooth. After a brief rest on the plaintiff's part, the defendant extracted the tooth, packed the cavity and sent the plaintiff home. The plaintiff's face became swollen and he returned the next day. After an examination, the defendant suggested that the plaintiff receive medical attention.

The plaintiff, it appears, was suffering from osteomyelitis. He became seriously ill, and spent several months in a hospital. The record also indicated that the infection was present at the time of the extraction of the tooth by the defendant.

On the foregoing facts, the plaintiff brought the instant action against the defendant for damages, claiming that the latter used an improper method to produce anesthesia when the tooth was extracted; in short, that the defendant used the infiltration method, which permitted the infection to get into the jawbone, and that the defendant should have used the conductive method and injected the anesthetic outside the infected region.

Upon trial, the evidence was in sharp conflict. The plaintiff introduced expert testimony that tended to support his contention that his injury resulted from negligence on the part of the defendant in selecting an improper method in administering the anesthetic. The defendant, on the other hand, denied this by his own testimony and the testimony of his own expert witnesses, who testified that the treatment was proper.

The case went to a jury. The latter decided in favor of the plaintiff, the amount of the verdict not appearing in the report. From judgment on this, the defendant appealed, and the higher court, in reviewing the record and in affirming the judgment, among other things, said:

> Whether this defendant used that standard of care which the law requires of him was a matter for expert testimony. . . . [an] expert witness, a practicing dentist of sixteen years' experience, testified, in answer to a hypothetical question, that the method of anesthesia used by the defendant was by infiltration; that the area around the tooth,

at the time the boy was presented to the defendant for dental services, was in an infected condition; that the defendant dentist did not use the kind of anesthetic suitable for the condition in question . . . that, under the condition described, the proper method would be conductive or general anesthesia, and that good practice required conductive anesthesia to prevent the spread of infection.

In answer, the defendant himself admitted that an anesthesia by infiltration on the lower jaw, as here, would not have been proper, and that in this case he used the approved mandibular (conductive) method. It was further testified by experts that the defendant used and exercised the skill that is required and ordinarily possessed by others in his profession in his treatment of the boy [plaintiff] and, further, that even if the infiltration method was used, it would be in keeping with proper practice in a great many instances.

Then, noting this conflict in the expert testimony upon which the jury had rendered its verdict for the plaintiff, the court, in declining to disturb the verdict, concluded:

. . . but we cannot here consider the quality or the amount of proof. To us there seems to have been . . . a conflict of fact that made for consideration by the jury. . . . The rule is that if there is any evidence standing alone, or considered apart from opposing evidence, it is, if believed by a jury, legally sufficient, or might reasonably tend to support the verdict, and though such evidence may not be of an entirely certain and satisfactory nature, it will not be disturbed, for, upon the mere weight of evidence, the jury are the judges. . . . The judgment will be affirmed, with costs.

So too, when a patient suffers injury while under the influence of an anesthetic, the dentist will, as a rule, be placed in a difficult position successfully to defend. At any rate, the burden of explanation will be upon him. For illustration, let us examine Wolfe *et al.* vs. Feldman, 286 N.Y.S. 118.

PATIENT SUFFERS INJURY

In this case, the plaintiff engaged the defendant, who specialized in oral surgery, to extract certain teeth. Anesthetic gas was administered and the teeth were extracted, and when the plaintiff regained consciousness, she noted pain in the little finger of her right hand. It later developed that the plaintiff had a fracture of the bone in that finger, and that this injury occurred while she was under the influence of the anesthetic in the defendant's office.

In due time, the plaintiff brought the instant action against the defendant for damages. The defendant's explanation of the accident, as taken from the report, was as follows:

The defendant's story is that the plaintiff was strapped to the operating chair; that a short time later, after the plaintiff was in the excitement stage of nitrous oxide anesthesia and as he moved closer to the chair to adjust the suction aspirator, the plaintiff, despite the limited movement of the strapped wrist, clutched his testicles with a painful grip, which required the use of great force to release. Thereafter he proceeded with the operation and when the patient had recovered from the anesthetic, she complained of pain in the right little finger. The following day, an x-ray film of the finger showed on the second phalanx a narrow line which looked like a fracture. Thereupon, he sent her to a doctor to have the finger treated.

Upon trial, the evidence was in conflict. The plaintiff claimed that the defendant was negligent in preparing her for the operation; that the defendant had no assistants, and that he did not apply any restraining straps.

The defendant, on the other hand, testified that he had two assistants present and that straps were applied. The statement of the defendant was corroborated by the two assistants, a doctor and a nurse, who testified as to what was done to prepare the plaintiff for the operation. On the foregoing record, the court in reasoning on the liability of the defendant, had this to say:

Where the defendant tacitly admits causing the injury, the acute problem is this:

Has the defendant satisfactorily explained the occurrence of the accident? The rule of *res ipsa loquitur* applies . . . and while the plaintiff must sustain the burden of proof of the defendant's lack of proper care, the defendant is obliged to come forward with proof that he observed reasonable care in the performance of these dental services.

If, as claimed by the plaintiff, the defendant alone was present at the time of the administration of the anesthetic and no restraining straps were applied to control the actions of the plaintiff after she became unconscious, it is clear that there was such lack of care and diligence by the defendant as constitutes negligence. If, on the other hand, as claimed by the defense, wrist straps were applied, it is quite evident that such application or fastening must not have been properly performed, else the very purpose for which such strapping is done was not accomplished.

Nor does the claim that it was impracticable to so fasten the straps as to prevent freedom of movement of the wrists and hands of the patient help the defendant, for in such case it was incumbent on him, during the time the patient was in the so-called "fighting stage" reached by patients undergoing anesthesia by nitrous oxide, not to place his body in such a position as to permit the plaintiff's hands to interfere with him to such an extent as to require the application of force sufficiently severe to cause her physical injury. The nonobservance of such duty constituted negligence. The degree of care required by the defendant under these circumstances might well be greater than ordinary care. . . .

For the defendant's failure to satisfactorily explain his failure to observe the degree of care necessary under the circumstances, the plaintiff should have judgment. . . .

In conclusion, judgment for $650 was rendered in favor of the plaintiff.

So much for the foregoing cases. Now let us turn to the related phase of the subject in hand; i.e., the duty of a dentist to make a physical examination of a patient before giving an anesthetic. This point too has been litigated in a number of well-reasoned cases, and, broadly speaking, the cases seem to hold that, in the absence of notice to him that the physical condition of a patient forbids the giving of a certain anesthetic, the dentist is not required to make a physical examination before anesthesia; this assuming that such examinations are not by custom given in his locality by dentists. For illustration:

In Eggert vs. Dramburg *et al.*, 197 Wis. 153, 221 N.W. 732, a woman applied to the defendants, practicing dentists, for services in extracting certain teeth. The defendants, observing that she was overweight, asked her a number of general questions, and as the answers did not indicate any danger to the patient from gas anesthesia, this was administered and the teeth were extracted.

The patient, it appears, had a weak heart, and she died in the defendants' office from excitement induced by the anesthesia. The instant suit for damages against the defendant followed, being based upon the contention that the defendants had been guilty of negligence in not making a physical examination of the patient before administering the anesthetic. In denying this contention, and in affirming a judgment for the defendants, the court reasoned:

The plaintiff's cause of action is based wholly on the claim that the defendants [dentists] did not exercise the degree of care and skill required of dentists in order to discover whether the deceased had a bad heart before they administered the anesthetic.

The proof discloses nothing to arouse any suspicion as to the physical condition of the decedent, except her overweight. The defendants testified that overweight has no bearing on the question whether a gas anesthetic can be safely administered. The plaintiff offered no proof to meet this testimony on the part of the defendants that it stands as a verity in the case.

There was no evidence to sustain the finding that the defendants did not exercise the degree of care and skill exercised by dentists in good standing in their community. If this was not true, it was the duty of the plaintiff to offer proof to establish that fact. The

only evidence offered by the plaintiff was the testimony of one physician that in a hospital with which he is connected the patient was always given a physical examination before an anesthetic was administered, whether teeth were to be extracted or some other operation performed.

There is no proof that it was usual and customary practice to make such examination in dentists' offices, in Milwaukee [defendants' locality], before giving an anesthetic for the purpose of extracting teeth. The proof comes far short of meeting the burden that rested on the plaintiff. Judgment affirmed.

So too, while a dentist is held to a high degree of care in the selection and administration of anesthetics, the mere fact of an unfortunate result will not, standing alone, constitute proof of negligence. The application of this rule is illustrated in a striking manner in Mitchell vs. Atkins, 36 Del. 451,178 Atl. 593.

ANESTHETIC ADMINISTERED WITH FATAL RESULT

Here, the plaintiff sued the defendant, a dentist, because of the death of her husband, which occurred subsequently to administration of an anesthetic for the extraction of a tooth. The plaintiff did not specify any act of negligence on the part of the defendant, but relied solely upon the mere fact of her husband's death, under the circumstances, as making a case against the defendant. In sustaining a demurrer to this claim, in other words in finding for the defendant, the court used the following language:

Here there is no allegation of negligence at all. Reliance is had solely upon the rule of *res ipsa loquitur* [the thing speaks for itself] operating upon the mere facts of administration of an anesthetic and subsequent death as establishing prima facie negligence sufficient to place upon the defendant some burden of justification. . . .

The mere fact that a patient dies under the influence of an anesthetic does not show negligence. . . . In an action of this kind, there must either be alleged and proved a lack of requisite knowledge or skill or there must be alleged and proved a failure to exercise a proper degree of care and diligence on the part of the defendant or, some negligence of the defendant being alleged, there should appear some state of facts connected with an instrumentality in the control of the defendant or with the treatment accorded the plaintiff which brings about a result so inconsonant with the normal and usual result that it must presuppose negligence in the application of the relief.

Assuming the truth of the allegation of count 4 [the count in which the death of the plaintiff's husband was recited], no cause of action is therein set out. The demurrer is sustained.

SUMMARY

On the foregoing cases, it is obvious that a dentist is held to a high degree of responsibility in the selection and administration of anesthetics, and that a failure to comply with recognized standards of practice may render him liable for resulting injury. On the other hand, he is not an insurer of results, and is only required to look to the natural and probable effects of such administration upon his patients.

In line therewith, a dentist is not required to make a physical examination of his patients before administering anesthetics, if this is not shown to be customary in his community; and if the information gained by the usual questions asked a patient does not disclose anything that should put a dentist on guard, the fact that injury results from the administration will not, in itself, render him liable.

So too, as we have seen, the doctrine of *res ipsa loquitur* does not, as a usual rule, apply to accidents growing out of the administration of anesthetics. To render a dentist liable therefore, there must be alleged and proved, in addition to the result, some act or acts of negligence on his part. The mere fact that a patient suffers injury—even death—will not, standing alone, constitute proof of negligence.

DENTAL PICKETING BARRED

SUPREME Court Justice Peter Schmuck has granted a temporary injunction restraining Chapter 101 of the Dental Technicians Equity, a C.I.O. affiliate, from picketing the dental office of Dr. Philip Back at 576 Fifth Avenue. The union is conducting a strike against the New Era Laboratory in the Bronx, which makes some of the dental laboratory work for Dr. Back.

The union based its right to picket on an alleged "unity of interest" between the laboratory and the dentist. On this ground, courts have permitted unions striking against a manufacturer to picket retail outlets for his product.

Justice Schmuck said in overruling this argument: "He (the plaintiff) sells no product identifiable by trade name; rather he has constructed at his personal direction various appliances each individual and distinctive for use by him as an incident to his calling as a professional man in the rendition of skilled service for compensation."—*New York J. Dent.*, July-August 1940.

CORRECTION

OUR attention has been directed by Homer C. Brown to an inaccuracy in the report entitled "A Review of the Mail Order Denture Problem," published in the July issue of THE JOURNAL. It was not, as reported, Martin Dewey who first filed complaint with the federal authorities relative to advertising of mail order dentures. The action in question was taken December 1932 by G. Walter Dittmar, who succeeded Dr. Dewey as President of the American Dental Association.

RESEARCH COMMISSION OF THE AMERICAN DENTAL ASSOCIATION

SURVEY OF CERTIFIED INLAY CASTING INVESTMENTS

(July 9, 1940)

SAMPLES of the inlay casting investments which had been certified to the Research Commission by the manufacturers were procured on the retail market by the Research Commission and were tested by the A.D.A. Research Associates at the National Bureau of Standards.

The following investments were found to comply with all requirements of A.D.A. Specification No. 4:

Investment	Manufacturer or Distributor
Coecal Inlay	Coe Laboratories, Inc.
Coecal Universal	
Kerr Cristobalite Inlay	Kerr Dental Mfg. Co.
Ransom & Randolph Gray	The Ransom & Randolph Co.
Ransom & Randolph Green	
Security Improved Inlay	The Cleveland Dental Mfg. Co.
S. S. White Inlay No. 20	The S. S. White Dental Mfg. Co.
Steele's Super	The Columbus Dental Mfg. Co.

CANDIDATES WHO SUCCESSFULLY COMPLETED PARTS I AND II OF THE NATIONAL DENTAL BOARD EXAMINATIONS DECEMBER 6 AND 7, 1939

CHICAGO COLLEGE OF DENTAL SURGERY

Dedekind, Kenneth L.
Herthneck, Robert G.
La Mothe, Daniel E.
Pearlman, Joseph
Riley, Medford S.
Schoen, Philip
Van Kley, LaVern A.

UNIVERSITY OF SOUTHERN CALIFORNIA

Lovestedt, Stanley A.

TEMPLE UNIVERSITY

Glasser, Morris M.

UNIVERSITY OF IOWA

Chapman, Claude E.
Hitzhusen, John
Oosterhuis, Arnold M.

UNIVERSITY OF PENNSYLVANIA

Steinman, Herbert

HARVARD UNIVERSITY

Morrow, Robert L.

BALTIMORE COLLEGE OF DENTAL SURGERY

Cavallaro, Ralph C.
Pessagno, E. L.

ATLANTA-SOUTHERN DENTAL COLLEGE

Blue, Irvin
McDaniel, Duard E.
Ray, Claudius
Walton, X. P.

COLUMBIA UNIVERSITY

Bien, Saul Marcus
Thomas, Bernerd O. A.

TUFTS DENTAL COLLEGE

Dooley, Richard J.
Lax, Martin

FREDERICK B. NOYES TO BE HONORED

FREDERICK B. NOYES, retiring dean of the University of Illinois, College of Dentistry, September 1, will be honored at a testimonial banquet on the evening of September 14. Because of the prominence of Dr. Noyes in organized dentistry, dental education and dental research, this occasion promises to be outstanding. The banquet, which is sponsored by the faculty of the University of Illinois, College of Dentistry, will be held at the Lake Shore Athletic Club, Chicago, the Saturday following the American Dental Association meeting in Cleveland. This date was chosen to make it possible for those attending the A.D.A. meeting to come to Chicago to join in honoring Dr. Noyes.

For further information or reservations, address Allan G. Brodie or Stanley W. Tylman, 808 South Wood St., Chicago.

American Dental Association Eighty-Second Annual Meeting

CLEVELAND, OHIO, SEPTEMBER 9-13, 1940

HONORED for many years as the "dean of American dentists," Harvey J. Burkhart will return to the city of his birth—Cleveland—to receive a special tribute from his many friends in the profession at the historic centennial convention of the American Dental Association.

Tuesday, September 10, has been set aside during the convention days, September 9 to 13, to mark Dr. Burkhart's outstanding accomplishments in preventive dentistry for children, through his work as general director of the Eastman dental clinics. Dr. Burkhart will reply to the expression of his colleagues at a luncheon in his honor.

National attention is being focussed on the convention in Cleveland as both the lay and scientific world view the event as a milestone in the march of civilization. Dental Health Week, beginning September 8, has been proclaimed by the governor of Ohio and the mayor of Cleveland in recognition of Dentistry's contributions to public health during the last hundred years.

The general sessions will bring speakers from the front rank of American opinion—Sen. James E. Murray, of Montana; the Rev. Norman Vincent Peale, distinguished author; Frederic Snyder, well-known news analyst, and Earnest Albert Hooton, of Harvard University, most prominent contemporary anthropologist.

More than 100 papers will be read at the section meetings and 350 clinics will be held. The panorama of our ten decades will be completed by the Hall of Exhibits with its 140 historical, scientific and health exhibits as well as 130 technical exhibits—the largest ever displayed.

It is expected that 10,000 dentists will come to Cleveland from all parts of the country to participate in the Eighty-Second Annual Meeting of the American Dental Association—certainly the most significant and important gathering in the history of the profession.

American Dental Association

Cleveland, Ohio September 9-13, 1940

HOTEL RESERVATIONS

To secure hotel accommodations for the 1940 Meeting, consult the rate list below and fill out the attached blank. Mail this immediately to the hotel of your choice or to the Housing Committee, Room 1241, Hotel Statler, Cleveland, Ohio. Confirmation will be sent to you by the hotel.

Second and third choices of hotel should be indicated. If the reservation cannot be made at any of the hotels of your choice, the Housing Committee will place you in as favorable a hotel as possible and will notify you.

Please remember that a reservation constitutes a contract with the hotel to provide you with the accommodations you desire. If you will find it impossible to carry out your part of the contract, namely, to occupy the room at the time agreed upon, please write or wire the hotel releasing the room, in order that it may be available for other members.

APPLICATION FOR HOTEL ACCOMMODATIONS

AMERICAN DENTAL ASSOCIATION

Cleveland, Ohio September 9-13, 1940

HOTEL.....1st choice

HOTEL.....2nd choice

HOTEL.....3rd choice

Kindly reserve the following: ☐ Single room ☐ Double room ☐ Twin beds.

.....rooms with bath for.....persons $.....per room

.....rooms without bath for.....persons $.....per room

Arriving on September.....at.....a.m.....p.m.

ROOMS TO BE OCCUPIED BY:

NAME	ADDRESS IN FULL
.....	.....
.....	.....
.....	.....

NOTE TO HOTEL NAMED AS FIRST CHOICE: If the hotel of first choice is unable to make the reservation requested, this application should be forwarded at once to the Housing Committee, Room 1241, Hotel Statler, Cleveland, Ohio.

SCHEDULE OF RATES

ALL ROOMS WITH BATH*

Hotels	Single	Double	Twin	Suites
ALCAZAR HOTEL Surrey & Derberyshire	$3	$5		$12–16
ALLERTON 1802 East 13th Street	2.50–3	4.50	5–5.50	
AUDITORIUM HOTEL E. 6th at St. Clair	2.50–3–3.50–4	4.50–5–5.50	6–7	
BOLTON SQUARE Carnegie at E. 89th St.		5	6	
CARTER HOTEL Prospect near 9th St.	2.75–3–3.50–4	4–5–6–7	6–7–8	12–19
CLEVELAND HOTEL Public Square & Superior St.	3–3.50–4–4.50	4.50–5–6–6.50	6–7–8–9–10	22–30
FENWAY HALL Euclid at University Circle			6–7	10–12
GARFIELD HOTEL Prospect at 38th Street	2.50	3		4–6
HOLLENDEN HOTEL Superior at 6th St.	3–3.50–4–4.50–5–6	5–5.50–6–6.50–7	6–6.50–7–8–10–12	12–40
LAKE SHORE 12506 Edgewater Drive				10–12
MECCA HOTEL 1862 East 9th Street	2	3.50–4		
OLMSTED HOTEL Superior at E. 9th St.	3	6–7	7	9–10–15
REGENT HOTEL 10539 Euclid Avenue		3	5	
STATLER HOTEL (Headquarters) Euclid at 12th	3–3.50–4–4.50–6	5–5.50–6–6.50–7–8	5–5.50–6–6.50–7–7.50–8	10–15
STERLING HOTEL Prospect at E. 30th St.		5	6	
SOVEREIGN 1575 East Boulevard		5–6	8	
STOCKBRIDGE HOTEL 3328 Euclid Avenue	2	3	4	
TUDOR ARMS Carnegie & 107th St.	3–3.50	5.50	6	7–12–20–30
WADE PARK MANOR E. 107th & Park Lane	3.50–4		6	8–10–12–15
WESTLAKE Blount Street	3.50	6		12

*Rate on rooms without bath by request.

NEWS ITEMS

AMERICAN ASSOCIATION OF DENTAL EDITORS

QUALIFICATIONS AND DUTIES OF A DENTAL EDITOR*

THE primary purpose of a dental journal is to be the mouthpiece, or avenue for the expression of thought, of the group it represents. A second, and no less important purpose, is to serve as a medium to convey these thoughts from one to another in an agreeable, acceptable and effective manner. The editor must act in the capacity of intermediary in facilitating this interchange.

As the objective of dental journalism is educational and informative, it is incumbent upon the editor to promote this objective in the most effective manner from his point of vantage. The success with which the journal fulfils these objectives is dependent in large measure upon the fitness of the editor for his position. While it is difficult to establish a "yardstick" for dental editorship, the nature of the work is such as to demand certain qualifications to assure success.

Naturally the first qualification for editorship is a good academic education upon which has been superimposed a thorough professional education, including a comprehensive understanding of the technical aspects of every phase of dentistry. From the literary point of view, the editor should have a good working knowledge of English, grammar, composition and rhetoric, to facilitate an ability to write and to express his views in a clear, lucid style, and to establish a literary standard to which all writings in THE JOURNAL should conform.

From the dental approach, we are impressed by the desirability of, and even necessity for, a thorough familiarity with the history of the dental profession. A good knowledge of the history of dentistry is a *sine qua non* of a good dental practitioner, and is indispensable in one who is to teach dentistry. One is certainly better equipped to direct the development of a profession if he is well grounded in its history. With this asset, and an unquenchable desire to keep in closest touch with the literature of the profession, an editor is better able to judge and follow the trend of dental thought and to discern the dental literary needs of his readers, and better qualified to supply them. His editorial writings should bear the mark of leadership, be thought provocative and timely, relate to current issues and topics of interest and concern to the particular groups represented and be devoid of uncomplimentary personal allusions. He must assume leadership in the educational field, and have sufficient stability and force of character to make that leadership influential toward the attainment of the high ideals of his profession. While the editor should in no wise depart from the principles for which he must stand, the post of editor is often diplomatic as well as educational.

The editor should be able to make decisions without hesitation in the selection of material. He should be able to say "no" regarding undesirable material and should uphold his convictions regarding the type of material sought and chosen. He should be tactful and diplomatic in the rejection of material palpably intended to publicize a particular project or individual. The kudos seekers, like the poor, we have with us always, and the editor must be on the alert lest he be exploited by those who would exploit themselves. He should have sufficient appreciation of his responsibility to realize the influence which writings

*Prepared for the Survey Committee (1939) of the American Association of Dental Editors (L. P. Anthony, W. J. Gies, M. K. Hine, chairman) by L. P. Anthony.

may have in determining the destiny of the profession and even of individuals.

In summary, we indorse the qualifications as prescribed by our late lamented and revered president, Dr. C. N. Johnson:

> After all, the thing we most need in editorial work is breadth of vision and tolerance for the opinions of others. If any man should be broad-minded, an editor should. If any man needs charity in his heart, an editor does. He touches human life at its most vital and its most intimate points.

As to the duties of an editor, we are of the opinion that his main duty is to develop and cultivate the attributes indicated herein, and to have the determination and courage to apply them unflinchingly to the discharge of his editorial responsibilities.

UNIVERSITY OF PENNSYLVANIA BICENTENNIAL CONFERENCE

THE University of Pennsylvania will celebrate the two hundredth anniversary of its founding September 16 to 20, 1940, at Philadelphia. The program of the Conference will consist of lectures and papers by a group of distinguished European and American scholars and leaders in the various fields of science and thought.

The contribution of the Dental Alumni Society to the celebration will be the following program:

Symposium, Medical Building
Wednesday, September 18

Morning

Epidemiology.
- Carroll Edwards Palmer, M.D., Ph.D., Passed Assistant Surgeon, Child Hygiene Studies, U. S. Public Health Service.
- Henry Klein, D.D.S., Sc.D., Dental Officer, Child Hygiene Studies, U. S. Public Health Service.

Relation of Bacteria and Fluorin.
- Basil Glover Bibby, D.D.S., Ph.D., Assistant Professor of Dentistry, School of Medicine and Dentistry, University of Rochester.

Relation of Diet and Nutrition.
- Elmer Verner McCollum, Ph.D., Sc.D., LL.D., Professor of Biochemistry, Johns Hopkins University.

Afternoon

Symposium: Development of Occlusion.
Phylogenetic Development Through Vertebrates, Mammals and Primates.
- William King Gregory, Ph.D., D.Sc., American Museum of Natural History.

Development in the Individual.
- B. Holly Broadbent, D.D.S., F.A.C.D., Fellow in Dental Anatomy, Director of the Bolton Fund, Birdsill Anatomical Laboratory, Western Reserve University.

Factors in Occlusion.
- Milo Hellman, D.D.S., Sc.D., Professor of Dentistry, Columbia University.

Thursday, September 19, Evans Institute

Morning

Annual meeting of the Dental Alumni Society.

Noon

Luncheon with the Dental Alumni Society as host.

Afternoon

Moving pictures; clinics by members of the dental faculty.

Visit to the studio of WCAU (Courtesy of Leon Levy).

Evening

6:30 p.m.: Annual Dinner of the Dental Alumni Society, Hotel Benjamin Franklin; tickets, $2.50.

Friday, September 20

Joint meeting with the General Alumni Society in its activities for the day and evening.

Z. T. JACKAWAY, *Secretary,*
1506 East Susquehanna Ave.,
Philadelphia.

CURRENT LITERATURE

Supernumerary and Missing Teeth in Wild Mammals of the Orders Insectivora and Carnivora, with Some Notes on Disease

By E. Raymond Hall

Examination of 2,256 insectivora and 3,761 carnivora, all in the Museum of Vertebrate Zoology of the University of California, at Berkeley, revealed no instances of missing teeth, extra teeth or diseased teeth in the insectivora. In the carnivora, many missing teeth and extra teeth were noted, and diseased teeth, cases of dento-alveolar abscess and seeming cases of parodontal disease are described. Dental caries was found only in bears, and it is suggested that bears are more frequently afflicted with dental caries than are other wild carnivores because bears normally eat food much richer in sugar. Other conclusions have to do with the parallelism between variation in the number of teeth in individual mammals and variation in the number of phylogenetic series of mammals.—*J. D. Res.*, 19:103, April 1940.

E. Raymond Hall.

Vincent's Stomatitis

By R. W. Leigh

This disease was not introduced to this country by troups returning from World War I, there being evidence that the disease was observed and described before then by W. D. Miller, R. T. Oliver, T. L. Gilmer and others. The first symptoms noticed by the patient are insomnia, anorexia and malaise, and positively pathognomonic are the drooling of bloody saliva during the night, evidenced by the stained pillow, and frequent bleeding upon brushing the teeth, eating or other slight provocation.

The saucer-shaped ulcers filled with a dirty gray exudate are seen on the interdental papillae. Often, there is glandular involvement. Upon removal of the pseudomembrane, a highly inflamed granulation tissue which bleeds quite profusely is revealed. Lesions are frequently unilateral. The condition is often confused with pyorrhea alveolaris. The differential diagnosis between the condition and syphilis and diphtheria is also important.

The disease probably occurred in epidemic form during 1918-1921. The exact cause of its spread is not clear. The common use of eating utensils or band instruments; sharing cigarets; kissing, etc., may help to pass the disease along. Complete quarantine is justifiable.

In treating the disease, all surgical measures should be postponed until the acute symptoms subside. Hydrogen peroxide or potassium permanganate 1:2,000 is prescribed as a mouth wash. Careful removal of the pseudomembrane by the dentist is strongly advised. The use of chromic acid should be discarded as a therapeutic measure because it decalcifies the teeth. Local treatment should consist of the elimination of local irritants, abnormal subgingival pockets and extraneous deposits and the application of oxidizing agents. A saline cathartic, liquid diet, with citrus fruits, and rest are prescribed.—*Mil. Surgeon*, 86:588, June 1940.

Arthur F. Fisher.

Sympathetic Nerve Fibers in the Alveolar Nerves and the Nerves of the Dental Pulp

By Kermit Christensen

This investigation was conducted to determine the rôle of the sympathetic nerves in the innervation of the teeth. The preparations studied were obtained from casts. It was found that the alveolar nerves include the sympathetic nerve fibers derived from the superior ganglion via the plexus on the external carotid and its branches. Few sympathetic nerve fibers actually enter the dental pulp. Chromatolysis resulted from section of the alveolar and mental nerves, blood vessels and surrounding connective tissue. Sympathetic nerve fibers terminate in the walls of the alveolar blood vessels, while others are distributed via the mental nerves.

Most of the nerve fibers in the dental pulp are myelinated.—*J. D. Res.*, 19:227, June 1940.

R. F. SOGNNAES.

C Hypovitaminosis und Paradentopathien biziehungsweise Zahnkaries (Vitamin C Deficiency in Relation to Paradental and Carious Lesions)

By F. RUSPA

OF fourteen patients with paradentitis, seven showed vitamin C deficiency. No deficiency was observed in six out of eight patients with extensive caries. Four patients with chronic inflammation of the gum, and three controls, appeared to have an adequate vitamin C supply. The sufficiency was determined after a daily intramuscular injection of 300 mg. of ascorbic acid.—*Ztschr. f. Stomatol.*, 38:11, March 194 .

R. F. SOGNNAES.

Studies on Dental Caries

By HENRY KLEIN and C. E. PALMER

A SYSTEM for the collection and analysis of dental examination findings is described. The authors explain in detail the use of a standard recording form and code system. When the data of each record have been summarized, a punch card is prepared for the mechanical sorting and tabulation. This system, which has been under test for more than three years, recording and processing nearly 14,000 examinations, has proved generally adequate for studies on the epidemiology of dental caries.—*J. D. Res.*, 19:243, June 1940.

R. F. SOGNNAES.

A Method for Staining Carious Lesions in Teeth

By G. GOMORI

THE technic for staining carious dentin lesions described is dependent on the reduction of a 0.25 to 0.5 per cent solution of silver nitrate by a 5 per cent solution of sodium hypophosphite. The reduced section is fixed with a 2 per cent hypo solution. Specimens may then be dehydrated, cleared and examined directly with a dissecting microscope, or they can be decalcified in 5 to 10 per cent sulfosalicylic acid and embedded in celloidin.—*Proc. Soc. Exper. Biol. & Med.*, 44:250, May 1940.

JOSEPH F. VOLKER.

In Vitro Experiments on the Exchange of Phosphates by Enamel and Dentin

By W. D. ARMSTRONG

WITH radioactive phosphorus as an indicator, the phosphorus exchange in the dentin was found to be approximately ten times that of enamel. The state of ionization of the phosphate had no effect on the rate of exchange with the dentin. Denatured dentin protein showed no ability to exchange with the labeled phosphate. It is believed that the greater rate of phosphate in the dentin as compared with enamel can be explained by (1) the crystal size of the mineral phase of the respective tissues, and (2) the trapping of the phosphate in the dentinal tubules. —*Proc. Soc. Exper. Biol. & Med.*, 44:28, May 1940.

JOSEPH F. VOLKER.

Light Scattering in Normal Human Dentin

By R. S. MANLY, J. F. BONNER and H. C. HODGE

THE authors have attempted to gain new knowledge on the structure of dentin by a study of the light-scattering characteristics. It was found that the empiric equation of Bloch and Revwick held for the relationship between transparency and the thickness of normal dentin. The coefficient for normal dentin is about 300 times the absorption coefficient. Transparent dentin, because it contains partially calcified tubules with less scattering surface, has a scattering coefficient one-twentieth that of normal dentin. The absorption constant, however, is not changed. —*J. Phys. Chem.*, 44:745, June 1940.

JOSEPH F. VOLKER.

Mandibular and Maxillary Hyperostoses

By ALES HRDLICKA

AFTER a rather thorough examination of several thousand people and of skulls from different parts of the world, many data on the occurrence of maxillary and mandibular hyperostosis were obtained. The statistical data are given in many charts in the article.

It was found that these cases of hyperostosis occur most frequently in the people of the Arctic and the Antarctic. The condition was least common in the Australians. The hyperostosis is non-pathologic. It usually starts to appear at about the time of adoles-

cence. The size varies extensively and the lesions are usually symmetrical. In the mandible, they appear between the mylohyoid and alveolar border, usually around the second premolar region, but they may extend from the incisors to the third molars.

In maxillary hyperostosis, there are two types, the torus and the alveolar. The alveolar may occur on the buccal or lingual aspect, or both, and on one or both sides of the jaw. There seems to be little connection between the maxillary and mandibular conditions in relation to occurrence. This bone is of the hard compact type and Dr. Hrdlicka believes that the condition indicates an effort of the organ to provide additional strength. —*Am. J. Phys. Anthropol.*, 27:1, June 1940.

E. WOODS.

Effect of Fevers on the Development of the Rat Incisors

By LELAND H. GARRISON

THE fact that fevers affect the formation of teeth has been a clinical observation for many years, but little laboratory work has been done to prove it. A group of twenty-one rats were put in an incubator and the temperature raised to 38.4° C. The rats showed marked variation in their ability to withstand the increased temperature. The maximum for any rat was 41.2° C.

These experiments demonstrated that the pulps were hyperemic, and the odontoblastic layer showed edema and reticular atrophy. This condition cleared up in two to three weeks after removal from the incubator. Changes in the dentin resulted. Two zones were produced, an outer believed to be hypocalcified and an inner believed to be hypercalcified. The width of the dentin changes were in proportion to the time spent in the incubator.—*J. D. Res.*, 19:3, February 1940.

E. WOODS.

Effect of Antiseptics on Wounds

By A. FLEMING

IN considering the action of various drugs, the bactericidal action has been stressed to almost complete exclusion of the bacteriostatic action of the drug. It has been demonstrated that the use of physiologic solution of chlorinated soda (Dakin's) for the production of antisepsis by Carrel's method is definitely not very effective. According to the method of use, the solution is instilled into the wound every two hours. Actually, the fluid maintains its antiseptic power for only ten minutes of the two hours when used in this way.

A physiologic action other than its antiseptic action is the increased transudation of fluid from the walls of the wound. This reaction is, by far, the more important of the two.

It has been found that certain antiseptic dyes have a marked affinity for dressings, the bactericidal action being greatly diminished thereby. This is especially true of gentian violet and acriflavine.

Experimentation has shown that it is almost impossible to sterilize a war wound with a chemical antiseptic; that pus has an antibactericidal effect, and that certain chemical antiseptics have an antileukocytic action.

Antiseptics are not indicated in septic wounds when bacteria have invaded the walls.—*Proc. Roy. Soc. Med.*, 33:487, June 1940.

A. PEARSON.

A New Sublethal Color Mutation in the House Mouse

By HANS GRUNBERG

A RECESSIVE gene is described in the house mouse which suppresses the formation of all yellow pigment in the coat and kills the homozygotes in from twenty-two to thirty days. There is also a lack of coordination of dentin formation and dentin calcification leading to a complete retention of the teeth, persistence of all spongiosa spicules of bone, poor development of periosteal bone and incomplete calcification in all cartilage and membrane bones with the exception of the flat bones of the neurocranium. The shape of the gray lethal skull, mandible and skeleton is altered, the upper incisors are rudimentary and there is a general arrest of bone growth.—*Proc. Roy. Soc. London, Ser. B*, 118:321, September 2, 1935.

GRANT VAN HUYSEN.

Etiology of Enamel Spindles in Human Teeth

By CARL AUGUST SCHLACK

ENAMEL spindles have been studied by nearly all dental histologists, and consequently have been attributed to several different conditions, among them dental defects,

artefacts, resorption and dental fixtures. They appear to be due to an interference with calcification, but until the mechanism of calcification is understood and spindles can be produced at will, the problem will remain unsolved.—*J. D. Res.*, 19:195, June 1940.

E. WOODS.

Cysts of the Jaws

By MAX H. JACOBS and HARRY STONE

THE authors present a new classification of cysts of the jaws. They place all cysts which occur in and about the jaws in two great classes; i.e., those lined with epithelium and those lined with connective tissue. A discussion of the various types of cysts is given, including a definition, etiology, histopathology, x-ray findings, diagnosis and treatment. Histories, x-ray films and photomicrographs of actual cases are presented. A division of cysts of the jaws into epithelial lined and connective tissue lined with their subdivisions serves as an accessory means of determining the proper method of treating these conditions.—*Am. J. Orthodontics*, 26:690, July 1940.

J. GINN.

Treatment of Trigeminal Neuralgia: Peripheral Nerve Block

By JAMES L. POPPER

THERE are two methods of treating this type of neuralgia, by alcohol injection or by operation. Operation is the only permanent treatment. It may, however, cause numbness and a certain amount of danger is connected with it. The injection is rather painful, but gives relief for about thirteen months. It gives patients a chance to see how much the numbness will bother them in the event of an operation and helps to establish the diagnosis. —*S. Clin. North America*, 20:663, June 1940.

E. WOODS.

Problem of Dental Care in the Public Health Program

By FRANK C. CADY

IN public health administration, dental disease is considered with those diseases that can be controlled but not prevented. The public health program is divided into two main divisions, dental education and dental service for the public. More emphasis has been placed on the educational phase of the problem because it costs less money. More attention must be directed by all health workers toward the service side of the dental health problem. U. S. public health surveys show that health departments, in some localities, spend from 1 to 2 per cent of their budget for the employment of dentists.

The author presents some interesting statistics. He says that the "dental problem is so serious and universal it will take the concerted action of all health workers and educators if in this generation we succeed in materially reducing the high rate of tooth morbidity and mortality."—*Am. J. Pub. Health*, 30:931, August 1940.

J. GINN.

Bactericidal Properties of Commercial Antiseptics

By W. A. BITTENBENDER, E. F. DEGERING, P. A. TETRAULT, C. F. FEASLEY and B. H. GWYNN

A STUDY of the effect of the pH on the bactericidal properties of various antiseptics was made with *Escherichia coli* and *Staphylococcus aureus* as the test organisms. Chlorazene, gentian violet, Listerine, Lysol, malachite green, mandelic acid, Pepsodent antiseptic and potassium permanganate show an increased bactericidal action when the hydrogen ion concentration of the medium is increased. Amphyl appears to have maximum bacteriostatic and bactericidal properties at a pH 7.0, and sulfonmerthiolate is most suitable in alkaline media.—*Ind. & Eng. Chem.*, 32:996, July 1940.

JOSEPH F. VOLKER.

Retruded Chins: Correction by Plastic Operation

By GORDON B. NEW and JOHN B. ERICH

IN the treatment of retruded mandibles, there are two objectives to be considered: the functional and the esthetic. The psychologic value of correcting facial deformities is inestimable in many cases and the mental satisfaction which some persons experience from the correction is very gratifying. Since a retruded mandible is a deformity of progressive severity during the growth of the jaws, the sooner the treatment is instituted in these cases, the more satisfying the ultimate results. This, perhaps, is the most important consideration in the management of these lower jaw defects. Many procedures

will accomplish these objectives to some degree. The authors are primarily concerned with surgical methods of a cosmetic nature to improve the facial contour. The etiologic factors associated with protruded chins are given as: (1) malocclusion; (2) a condition primarily due to arrest of growth of the lower jaw and secondarily to the subsequent malocclusion, and (3) recession of the chin not associated with malocclusion. The procedures advocated for the correction of retruded chins are (1) various types of osteotomy through the horizontal or ascending rami to lengthen the mandible; (2) osteotomy through the horizontal rami associated with bone grafts to lengthen the mandible; (3) cartilage implants inserted behind the head of the condyles for the advancement of the mandible; (4) cartilage, bone, ivory and celluloid implants for building up the chin to normal contour; (5) the use of prosthetic appliances requiring intraoral skin grafts for restoration of normal chin contour, and (6) orthodontia.

The authors present several diagrams and photographs showing cases before and after treatment by cartilage implants and prosthetic appliances and a combination of these methods. It is agreed that no single method is adaptable for the treatment of every patient with a retruded mandible.—*J.A.M.A.*, 115: 186, July 20, 1940.

J. GINN.

Treatment of Acute Stomatitis

By CHARLES H. SMITH and HERBERT B. JOHNSON

THE classification and nomenclature of acute stomatitis is badly confused. There are two common acute inflammatory conditions of the mouth in addition to thrush. First, there is the ordinary "canker sore," which may be noticed on the tongue, lips, floor of the mouth or cheeks. This condition is not accompanied by any constitutional symptoms. Second, there is an acute disease in children 1 to 3 years of age. Adults may contract this same condition in rare instances. Usually, there is fever, with pain and prostration. In one to two days, inflammatory lesions are found in the mouth. There is much pain on eating, a foul odor, drooling and cervical adenitis. The gums, which are the main site, become swollen and ulcerated.

All types of treatment have been instituted, including the use of potassium chlorate, perborate, gentian violet, intravenous arsphenamine and caustics. The treatment found to be very satisfactory by the authors is the application of chromic acid (a 7 per cent solution) with cotton swabs to the ulcerated gum areas, which have been previously dried and cleaned of all sloughing material by means of a mouthwash. It has been found best to dry and treat a small portion of the arch at a time, not more than one half to a third of the dental arch at one time. The treatment is repeated twice a day for from one to three days, then once a day.—*J. Pediat.*, 17:1, July 1940.

A. PEARSON.

Compound Composite Odontome

By E. K. TRATMAN

THE author reports the case of a male patient, aged 21, in whom the upper right cuspid was absent and there was a hard, smooth bony swelling on the upper part of the alveolus in the cuspid and premolar region. The x-rays revealed the unerupted cuspid and a number of small denticles.

Operation disclosed nine denticles in all, two of which were 1.5 cm. in length. This type of condition is reported to be quite rare. Cases of this kind are classified by some men as cystic, but this is considered to be merely an x-ray diagnosis, and not an actual finding on removal of such an area. In every case, there is present a dense fibrous capsule around the entire area.—*Brit. D. J.*, 69:12, July 1, 1940.

A. PEARSON.

Taste Threshold and Taste Preferences of Rats for Five Common Sugars

By C. P. RICHTER and K. H. CAMPBELL

RATS were given a choice of distilled water and slowly increasing concentrations of five common sugars. The rats distinguished between distilled water and sugar solutions as low as 0.06 per cent (maltose). Next in preference after maltose was glucose, sucrose and galactose, while lactose was refused.

Greatest preference was shown for solutions near 10 per cent, which is that of popular sweetened drinks.

In line with their previous studies of self-selection of foods, the authors conclude that of the four sugars, maltose may be most properly utilized.—*J. Nutrition*, 20:31, July 1940.

R. F. SOGNNAES.

INCIDENTS OF PRACTICE

Roentgenographic Diagnosis

By MILTON B. ASBELL, D.D.S., Camden, N. J.

History.—D. E., a woman, aged 25, complained of pain on the right side of the face and toothache in the right molar region. The pain occurred only when anything hot or cold touched the site and intermittently during the night.

Examination.—Clinically, there appeared to be large amalgam fillings in the lower right first and second permanent molars, and on the distal aspect of the second, showing extensive caries. Roentgenographic examination revealed extensive caries of the second

molar (with no apical disease). Between the roots of the first molar was a radiolucent area clearly outlined, conforming to the space between the apices and even extending below the apex of the distal root. Although there was caries beneath the distal portion of the amalgam filling, it did not seem deep enough to suggest apical disease.

Diagnosis and Treatment.—Since excavation of the cavity in the second molar proved unwise, the tooth was extracted under local anesthesia. On examining the roentgenogram, Harold Goldstein, of the Department of Oral Diagnosis, University of Maryland Dental School, expressed the opinion that the questionable radiolucent area between the apices of the first molar was an enlarged medullary space. Upon his suggestion, the tooth was restored by a new amalgam filling. For the past six months, there has been no recurrence of pain.

This is a case in which a careful roentgenographic diagnosis saved the tooth in question.

632 Federal Street.

Strabismus of Dental Source

By MEYER COHEN, Kenosha, Wis.

History.—A white boy, aged 16, came to my office in September 1939 because he had been kicked in the mouth while playing football.

Examination.—Examination of the mouth revealed fractured crowns on both upper central incisors. The teeth of both arches were crowded, the two lower second bicuspids being in lingual version and impacted between

the first bicuspids and the first molars. Caries was extensive throughout the mouth.

Roentgenograms revealed the presence of two supernumerary teeth lying in the palatal bones of the maxilla just posterior to the central incisors.

Strabismus was present with constant blinking of the eyes. For years, the patient had suffered from constant headache. A number of specialists had been consulted but without any apparent success in straightening the eyes.

Because the upper central incisors did not respond to a pulp test, it was decided to remove them and to remove the supernumerary impacted teeth also.

Operation.—An operation was performed under local anesthesia and the supernumerary teeth were removed through a flap made on the palate. At the same time, the two central incisors were extracted. Postoperative healing was uneventful.

Outcome.—Three weeks after the opera-

tion, the eyes were perfectly straight and the blinking had stopped. Up to July of this year, when I last saw the patient, he had been entirely free from headaches.

The accompanying roentgenogram shows the impacted supernumerary teeth. On removal, one tooth had the appearance of an underdeveloped cuspid, the other that of an underdeveloped bicuspid.

611 Fifty-Sixth Street.

Unusual Anatomic Markings in the Mandible

By M. SCHNEIDER, D.D.S., Chicago, Ill.

I AM presenting herewith a case of unusual anatomic marking in the mandible in a man, aged 45.

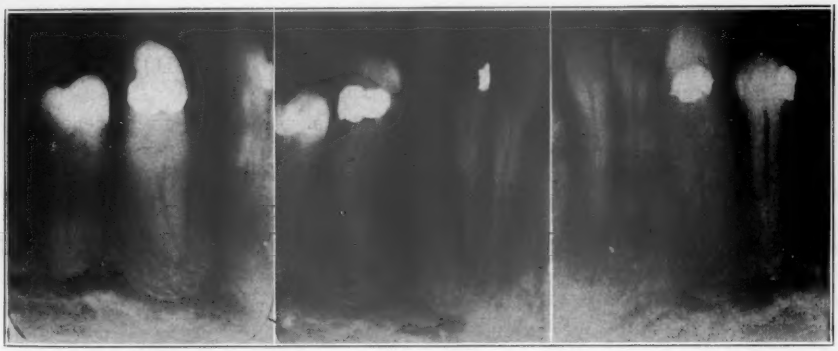

Fig. 1. Fig. 2. Fig. 3.
Unusual anatomic markings in the mandible.

Figure 1 shows four interdental canals, two mesial to the left cuspid and two mesial to the right cuspid. The distal canal near the left cuspid seems to be continuous with the inferior dental canal on the left side. The mesial canal of the right cuspid seems to be continuous with the inferior dental canal on the right side.

In Figure 2, the inferior canal seems to be continuous with the distal interdental canal near the left cuspid.

In Figure 3, the inferior dental canal is on the right side.

2651 North Cicero Avenue.

Closed Bite Causing Incessant Swallowing and Throat Distress

By HENRI A. TOSCA, D.D.S., Philadelphia, Pa.

A woman, aged 54, and apparently in good health, although visibly nervous and apprehensive, presented herself for dental attention. She had been suffering from a throat condition for the past eight years. During that time, she had visited many physicians and her condition was variously diagnosed as tonsillitis, hyperthyroidsm, enlargement of the epiglottis, endocrine disturbance due to the menopause, etc. After eight years of constant attention and medication, the condition remained unchanged.

The report of one of the physicians consulted was as follows:

History.—The patient complained of a choking sensation in the throat and nervousness, but no loss of weight. She was operated upon on three different occasions. Renal calculi were removed; a tumor, probably benign, was removed from the thigh and back and a hysterectomy performed eight years ago. Ever since the hysterectomy, the nervous symptoms had been quite annoying and were accompanied by "flushes."

Examination.—There was a moderate diffuse enlargement of the thyroid gland. The skin was cold, but showed prominent derma-

tographia. The heart showed some widening of the aorta, but no other abnormalities. The lungs were clear. The pulse rate was 70; blood pressure, 120/90. The abdomen showed a postoperative scar and some flatulence was evident. There was no weakness of the quadriceps femoris muscle group, nor was there any tremor of the outstretched fingers of either hand.

Laboratory Findings.—The basal metabolic rate was normal; blood count: hemoglobin, 12 gm.; red cells, 4,080,000; white cells, 6,900, with polymorphonuclears, 68 per cent, lymphocytes, 30 per cent and monocytes, 2 per cent. The urine was straw colored, clear and acid, with specific gravity 1.020, no sugar and a very faint trace of albumin. Microscopic examination revealed mucus shreds, 2+; amorphous urates, 2+ and four to six white blood cells per low-power field.

COMMENT

The physician's impression was that the patient's symptoms were purely functional in type, and in all probability related to artificial menopause.

"I feel that there is a growth or something stuck in my throat" were the patient's words. As she spoke, I noticed she swallowed incessantly, interrupting her conversation as she did so. Very often, she said, she was aroused from a sound sleep with a sensation of strangling. When she did sleep, her husband complained of her loud, weird snoring.

On examining the patient orally, I found an unusually overdeveloped tongue confined in a rather low restricted vault. Further inspection revealed gross wear of the occlusal surfaces of the lower posterior teeth, from first bicuspid to third molar. As a consequence, the interdental dimension was greatly reduced, with a greater confinement of the overdeveloped tongue. The cause of the incessant swallowing was now apparent.

Could this throat condition be purely of dental origin?

When the patient returned a few days later, I had her bite on two pieces of soft modeling compound, each placed along the occlusal surfaces of all the posterior teeth, at the same time guiding the bite in such a manner as to allow a 3 mm. increase of the interdental dimension. The compound was then chilled, hardened and held in position by the teeth for approximately twenty minutes. After that period, the patient ceased swallowing and her throat was measurably relieved.

Onlays were constructed on all of the lower posterior teeth, permanently establishing the newly recorded arch relationship. The results were amazing. The throat symptoms have completely disappeared, the patient enjoys uninterrupted sleep and is less nervous, showing a marked improvement in general health.

Tooth Fusion

By C. J. KIRWAN, D.D.S., Detroit, Mich.

THE accompanying roentgenogram shows a case of two lateral incisors together, one canal being filled.

This case is also interesting because chronic sacro-iliac pain disappeared about a week after extraction of both the lateral incisor and the cuspid.

Infection of a Third Molar, with Deafness

By D. C. WOODALL, D.D.S., Erwin, N. C.

A man, aged 46, had a badly swollen, extremely painful infected mandibular third molar on the left side, the condition having developed about twenty-one days previously.

He stated that he had been totally deaf on the same side for about ten days. The area was lanced and drainage began immediately. Within two hours, the pain had entirely subsided. The patient returned twenty-one days later, stating that he had no pain at all, but was still totally deaf on the affected side. The tooth was then extracted, and in three days hearing was restored.

Bank of Hartnett Building.

PRACTICE IN PARAGRAPHS

The Electrocautery—Many of us have an electrocautery on our units which are seldom used. If you wish to do away with the use of matches at the chair, you may do so with the help of the electrocautery. Keep the cautery adjusted at all times so the press of the button will cause the wire to become red hot. This heated cautery will light the gas as quickly and conveniently as matches.—*Meyer M. Silverman, 3500 Fourteenth St., N. W., Washington, D. C.*

Quick-Setting Cement—The addition of 1 or 2 drops of eugenol to the liquid in mixing cement for bases will assure a mix thick enough to be rolled into a ball and conveniently placed in the prepared cavity. It is tamped to place with amalgam pluggers and thereby the cement is kept away from the margins of the cavity. The filling can be placed immediately since this mixture sets very rapidly. Bases are also inserted in this manner in starting gold foil restorations, as the foil can be condensed at once into the semiplastic mass.—*Thurston D. Knowles, 177 Post St., San Francisco, Calif.*

Gagging—I have a patient who gags as soon as an attempt is made to examine his mouth with a mirror. I had to take an upper impression in dentocoll for a partial plate. I tried lozenges, procaine injections in the palate and the usual breathing technic to avoid gagging, but all for naught. Finally, I tried nitrous oxide gas, using the larger McKesson machine. I started the patient at 50 per cent nitrous oxide and 50 per cent oxygen, varying the percentage as I saw the anesthesia lightened or deepened, keeping the patient in the analgesia stage. I then proceeded with the dentocoll impression, with the usual technic. The impression was well nigh perfect and the patient felt no ill effects. Previous instructions not to eat had been given him.—*M. Skoblow, 315 Sixteenth St., West New York, N. Y.*

Simplified Bite-Rim Construction—Moisten the denture model and the thumb and forefingers; center the base-plate over the model and, using the brush flame of the waxing torch, sweep the heat from the center of the base-plate outward. Quickly adapt the base-plate with the thumb and forefinger over the vault area and then at the peripheral borders with the blunt end of the wax spatula. Chill in running water and remove from the model. Reverse the base-plate and trim off excess material with the heated point of a sharp knife, following the peripheral outline impress. Readapt to the model, chill and remove and smooth the periphery with a carborundum denture-trimming stone.

Heat one and one-half sheets of pink base-plate wax in warm water and roll into arch form. Heat the ridge area of the base-plate with a waxing torch and adapt the warmed wax rim to the base-plate with the fingers. Trim for height and width accordingly after thoroughly chilling, making certain that peripheral

borders are well adapted and that the bite-rim does not rock. Extend the anterior cleft for free movement of the labial frenum.—*G. Sidney Jacks, 4125 Montrose Ave., Chicago, Ill.*

Experimental Studies of the Possible Use of Heat-Treated Plastics in Inlay Construction—The wide use of plastics in denture work prompted me to apply them experimentally to restorative work. The following results were apparent in using the new methylmethacrylate resin:

In inlay construction by the direct method, there was an extremely snug fit with good margins, remarkable strength (comparable to that of amalgam or better) and a nice appearance, but with some objectionable pitting of the surface.

By the indirect method, a looser but more workable fit was secured, but the margins were naturally not so good as with the direct method. The gingival overlap could be corrected with sanded linen strips.

In practical restoration by the indirect method, results indicated that the acrylic inlay was stronger than a corresponding silicate for posterior use and was less prone to fracture. Weak margins could be easily reinforced with a duplicate technic, whereas a weakened silicate restoration appeared very hard to correct. In using the material, a cement reinforcement was necessary over the packed moist, spongy resin and packing of the cavity to slight excess was adhered to. The "inlay" was boiled for one hour, stoned, disked and polished on the model. A final finish in the mouth was secured with pumice and whiting on moist prophylactic brushes. Future experimentation in prevention of slight pitting of the material and control of expansion of the model or the material itself, and application of various color factors would probably forecast a useable substitute for present-day synthetics and possibly a major use of gold and amalgam in operative work (inlays). Perhaps fusion of plastics chemically would solve the problem of restorative construction with this material by the indirect method.—*G. Sidney Jacks, 4125 W. Montrose Ave., Chicago, Ill.*

Safe and Quick Method for Enlarging Root Canal for Post Reception Following Regular Root Canal Treatment—Remove the guttapercha filling the canal with a hot point to a depth of about two-thirds of the root length. Insert the last used root canal file or reamer, say a No. 3, taking a long one so that enough of it will protrude from the top of the root to indicate the direction of the canal. Use a No. 2 round bur on the straight handpiece, or contra-angle, according to the case, holding the bur parallel in all directions to the reamer. While keeping this position with the left hand, remove the reamer and insert the bur, using gradually larger ones. Repeat the process with a reamer as a guide as the widening goes on, in order to maintain a parallel direction.—*I. Gerson, 17, Kasr el Nil St., Cairo, Egypt.*

ANNOUNCEMENTS

ANNOUNCEMENTS must be received by the fifth day of the month in order to be published in the forthcoming issue of THE JOURNAL.

CALENDAR OF MEETINGS

ALPHA OMEGA FRATERNITY, Baltimore, Md., December 29-31.

AMERICAN ACADEMY OF PERIODONTOLOGY, Cleveland, Ohio, September 5-7.

AMERICAN ACADEMY OF RESTORATIVE DENTISTRY, Cleveland, Ohio, September 7-8.

AMERICAN ASSOCIATION FOR THE ADVANCEMENT OF ORAL DIAGNOSIS, October 17-18, New York, N. Y.

AMERICAN ASSOCIATION OF DENTAL EDITORS, Cleveland, Ohio, September 7.

AMERICAN ASSOCIATION OF PUBLIC HEALTH DENTISTS, Cleveland, Ohio, September 8-10.

AMERICAN COLLEGE OF DENTISTS, Cleveland, Ohio, September 8.

AMERICAN CONGRESS OF PHYSICAL THERAPY, Cleveland, Ohio, September 2-6.

AMERICAN DENTAL ASSISTANTS ASSOCIATION, Cleveland, Ohio, September 9-12.

AMERICAN DENTAL ASSOCIATION, Cleveland, Ohio, September 9-13.

AMERICAN DENTAL HYGIENISTS' ASSOCIATION, Cleveland, Ohio, September 9-13.

AMERICAN FULL DENTURE SOCIETY, Cleveland, Ohio, September 7-8.

AMERICAN PUBLIC HEALTH ASSOCIATION, Detroit, Mich., October 8-11.

AMERICAN SOCIETY FOR THE ADVANCEMENT OF GENERAL ANESTHESIA IN DENTISTRY, New York, N. Y., October 28.

AMERICAN SOCIETY FOR THE PROMOTION OF DENTISTRY FOR CHILDREN, Cleveland, Ohio, September 9.

AMERICAN SOCIETY OF ORAL SURGEONS AND EXODONTISTS, Cleveland, Ohio, September 6-7.

ASSOCIATION OF AMERICAN WOMEN DENTISTS, Cleveland, Ohio, September 9.

ASSOCIATION OF MILITARY SURGEONS OF THE UNITED STATES—DENTAL SECTION, Cleveland, Ohio, September 10.

UNIVERSITY OF BUFFALO DENTAL ASSOCIATION, Buffalo, N. Y., October 8-10.

CHICAGO DENTAL SOCIETY, MIDWINTER MEETING, February 17-20, 1941.

DISTRICT OF COLUMBIA DENTAL SOCIETY, second and fourth Tuesdays in each month from October to June at the United States Public Health Service Auditorium, Washington.

GREAT LAKES ASSOCIATION OF ORTHODONTISTS, Toronto, Canada, October 28-29.

GREATER NEW YORK DENTAL MEETING, Hotel Pennsylvania, New York, December 2-6.

GREATER PHILADELPHIA ANNUAL MEETING, February 4-7, 1941.

INTERNATIONAL COLLEGE OF DENTISTS, Cleveland, Ohio, September 8.

NATIONAL ASSOCIATION OF DENTAL EXAMINERS, Cleveland, Ohio, September 7-8.

NATIONAL BOARD OF DENTAL EXAMINERS, December 2-3.

NINTH DISTRICT DENTAL SOCIETY OF PENNSYLVANIA (OLD LAKE ERIE), Cambridge Springs, September 27-28.

ODONTOLOGICAL SOCIETY OF WESTERN PENNSYLVANIA, Pittsburgh, October 15-17.

DENTAL ALUMNI SOCIETY, University of Pennsylvania, Philadelphia, September 19.

PIERRE FAUCHARD ACADEMY, Cleveland, Ohio, September 9.

PSI OMEGA, Cleveland, Ohio, September 9-10.

ST. LOUIS (MO.) DENTAL SOCIETY (MIDCONTINENT DENTAL CONGRESS), October 27-30.

STATE SOCIETIES

October

Southern California, at Los Angeles

November

Florida, at St. Petersburg (11-13)
Ohio, at Cincinnati (25-27)

February (1941)

Minnesota, at Minneapolis (25-27)

April (1941)

Massachusetts (14-17)

May (1941)

Georgia, at Savannah (19-21)
Illinois, at Peoria (12-15)
Virginia, at Old Point Comfort (5-7)

STATE BOARDS OF DENTAL EXAMINERS

California, at San Francisco, December 16. Kenneth I. Nesbitt, 515 Van Ness Ave., San Francisco, Secretary.

New Jersey, December 9-14. Walter A. Wilson, 148 West State St., Trenton, Secretary.

Pennsylvania, at Philadelphia and Pittsburgh, December 10-14. Reuben E. V. Miller, 61 North Third St., Easton, Secretary.

Wisconsin, at Milwaukee, December 16-20. S. F. Donovan, Tomah, Secretary.

ALPHA OMEGA FRATERNITY

THE annual convention of the Alpha Omega Fraternity will be held at the Belvedere Hotel, Baltimore, Md., December 29-31.

EMANUEL HOFFMAN, *Publicity Manager,*
827 West 36th St.,
Baltimore, Md.

AMERICAN ASSOCIATION FOR THE ADVANCEMENT OF ORAL DIAGNOSIS

THE two-day meeting of the American Association for the advancement of Oral Diagnosis, October 17-18, in the New York Academy of Medicine Building, New York, N. Y., will come at the end of the first week of the Graduate Fortnite of the Academy. Prominent members of the dental and the medical professions will participate in the programs as clinicians, essayists and discussors, covering subjects of common and practical interest to members of both professions.

A dentomedical exhibit on oral and physical diagnosis will be presented during the meeting, stressing the significance of early and correct diagnosis in the field of prevention and the importance of periodic examinations, enabling those who visit the exhibit to obtain important and practical suggestions that can be applied in the everyday practice of dentistry and medicine. Members of both professions who are in good standing in their respective organizations are eligible for membership.

For further information relative to membership, organizing of regional divisions, etc., communicate with the secretary, H. Justin Ross, 515 Madison Ave., New York, N. Y.

AMERICAN ASSOCIATION OF DENTAL EDITORS

THE American Association of Dental Editors will hold its annual meeting in the Statler Hotel, Cleveland, Ohio, Saturday, September 7. An all-day program has been arranged and editors are urged to attend.

O. W. BRANDHORST, *Secretary,*
4952 Maryland Ave.,
St. Louis, Mo.

AMERICAN ASSOCIATION OF PUBLIC HEALTH DENTISTS

THE annual meeting of the American Association of Public Health Dentists will be held in the Rose Room, Hotel Cleveland, Cleveland, Ohio, September 8-10.

F. C. CADY, *Secretary,*
U. S. Public Health Service,
Washington, D. C.

AMERICAN COLLEGE OF DENTISTS

THE Cleveland convocation of the American College of Dentists will be held in the Statler Hotel, Sunday, September 8. There will be morning, luncheon, afternoon and evening sessions.

O. W. BRANDHORST, *Secretary,*
4952 Maryland Ave.,
St. Louis, Mo.

AMERICAN CONGRESS OF PHYSICAL THERAPY

THE nineteenth annual scientific and clinical session of the American Congress of Physical Therapy will be held September 2-6, at the Hotel Statler, Cleveland, Ohio. For information concerning the seminar and preliminary program of the convention proper, address the American Congress of Physical Therapy, 30 North Michigan Ave., Chicago, Ill.

AMERICAN FULL DENTURE SOCIETY

THE American Full Denture Society will hold its twelfth annual meeting in the Carter Hotel, Cleveland, Ohio, September 7 and 8.

AMERICAN PUBLIC HEALTH ASSOCIATION

THE Oral Health Group of the American Public Health Association will hold its annual luncheon, October 9, at 12 m., at the Hotel Statler, Detroit, Mich. Nathan Sinai, of the University of Michigan Public Health School, will speak on "Where Is Dentistry Going in Public Health?" Members of the American Dental Association are invited to attend this luncheon meeting.

W. H. PHILLIPS, *Chairman,*
Local Arrangements Committee,
Oral Health Group.

AMERICAN SOCIETY FOR THE ADVANCEMENT OF GENERAL ANESTHESIA IN DENTISTRY

THE next meeting of the American Society for the Advancement of General Anesthesia in Dentistry will be held in New York, N. Y., October 28, 8:30 p.m., at Midston House, Thirty-Eighth St. and Madison Ave. The dental profession is invited to attend.

M. HILLEL FELDMAN, *Secretary,*
730 Fifth Ave.,
New York, N. Y.

ASSOCIATION OF AMERICAN WOMEN DENTISTS

THE Association of American Women Dentists will hold its nineteenth annual meeting in Cleveland, Ohio, September 9, at the Cleveland Hotel. The objective of this association is to promote good fellowship and cooperation among its members and to aid in the advancement of women in dentistry. An interesting program has been planned and all members are urged to attend this meeting. All women dentists who are members of the A.D.A. are cordially invited to join the Association of American Women Dentists.

ASSOCIATION OF MILITARY SURGEONS OF THE UNITED STATES—DENTAL SECTION

A DINNER meeting of the Dental Section of the Association of Military Surgeons of the United States will be held in conjunction with the annual meeting of the American Dental Association September 10 at 6:30 p.m., Statler Hotel, Cleveland, Ohio. Delegates and representatives of all services will be present. Captain Conrad C. Gilkinson, Cleveland, is chairman of the dinner committee.

JOHN H. FREDERICK,
Major, DC, Maryland National Guard,
7 Elmhurst Road,
Baltimore, Md.

UNIVERSITY OF BUFFALO DENTAL ASSOCIATION

THE fortieth annual meeting of the University of Buffalo Dental Association will be held October 8-10, at the Hotel Statler, Buffalo, N. Y. The Eighth District Dental Society of the State of New York is cooperating in developing the program. All ethical practitioners are invited to register and to attend these sessions.

LEON J. GAUCHAT, *Publicity Chairman.*

CHICAGO DENTAL SOCIETY MIDWINTER MEETING

THE Seventy-Seventh Annual Midwinter Meeting of the Chicago Dental Society will be held at the Stevens Hotel, February 17-20, 1941. Members of the American Dental Society are invited to attend.

LEO W. KREMER, *Secretary,*
30 North Michigan Ave.,
Chicago, Ill.

GREAT LAKES ASSOCIATION OF ORTHODONTISTS

THE fourteenth annual meeting of the Great Lakes Association of Orthodontists will be held at the Royal York Hotel, Toronto, Canada, October 28-29.

RICHARD E. BARNES, *Secretary,*
Republic Bldg.,
Cleveland, Ohio.

INTERNATIONAL COLLEGE OF DENTISTS

THE Mid-Year Meeting of the International College of Dentists (U.S.A. Section) will be held in the Salle Modern, Hotel Statler, Cleveland, Ohio, Sunday, September 8, at 6 p.m.

ELMER S. BEST, *Registrar,*
801 Medical Arts Bldg.,
Minneapolis, Minn.

MIDCONTINENT DENTAL CONGRESS

THE Midcontinent Dental Congress will be held under the auspices of the St. Louis Dental Society at the Hotel Jefferson, St. Louis, Mo., October 27-30.

VAL H. FREDERICH, *Secretary,*
Arcada Bldg.,
St. Louis, Mo.

NATIONAL ASSOCIATION OF DENTAL EXAMINERS

THE annual meeting of the National Association of Dental Examiners will be held in Cleveland, September 7-8.

R. P. THOMAS, *Secretary,*
Heyburn Building,
Louisville, Ky.

NATIONAL BOARD OF DENTAL EXAMINERS

THE National Board of Dental Examiners will hold its next session for the examination of candidates in Parts I and II, December 2-3, in schools where there are five or more

candidates. For information and application, address

MORTON J. LOEB, *Secretary,*
66 Trumbull St.,
New Haven, Conn.

NINTH DISTRICT DENTAL SOCIETY OF PENNSYLVANIA (OLD LAKE ERIE)

THE Ninth District Dental Society of Pennsylvania (Old Lake Erie) will hold its annual meeting at the Bartlett Hotel, Cambridge Springs, September 27-28.

FRED M. HOLSTEIN, *Secretary,*
Grove City.

ODONTOLOGICAL SOCIETY OF WESTERN PENNSYLVANIA

THE Annual Fall Convention of the Odontological Society of Western Pennsylvania will be held in Pittsburgh at the William Penn Hotel, October 15-17.

JAMES M. MCNERNEY, *Secretary,*
8127 Jenkins Arcade,
Pittsburgh.

GREATER PHILADELPHIA ANNUAL MEETING

THE Greater Philadelphia Annual Meeting will be held February 4-7, 1941, at the Benjamin Franklin Hotel.

ABRAM COHEN, *Chairman,*
Publicity Committee,
269 South 19th St.,
Philadelphia, Pa.

PIERRE FAUCHARD ACADEMY

A MEETING of the Pierre Fauchard Academy will be held Monday, September 9 in Parlor C, Hotel Statler, Cleveland, Ohio.

ELMER S. BEST, *Secretary,*
801 Medical Arts Bldg.,
Minneapolis, Minn.

PSI OMEGA

ALL Psi Omegas attending the Eighty-Second Annual Session of the American Dental Association are invited to the dinner dance of the fraternity at the Hotel Cleveland, September 9 at 6:30. Headquarters will be at the Cleveland Hotel and members are asked to register during the session. The business meeting will be held September 10 at 10 a.m. at fraternity headquarters.

JAMES H. FERGUSON, JR.,
Grand Master, National Alumni Chapter,
Medical Arts Building,
Baltimore, Md.

GEORGIA DENTAL ASSOCIATION

THE seventy-third annual meeting of the Georgia Dental Association will be held at Savannah, May 19-21, 1941, with headquarters at the Hotel DeSoto.

R. H. MURPHY, *Secretary,*
Macon.

MASSACHUSETTS DENTAL SOCIETY

THE Massachusetts Dental Society will meet April 14-17, 1941.

PHILIP E. ADAMS,
106 Marlboro St.,
Boston.

ILLINOIS STATE DENTAL SOCIETY

THE next annual meeting of the Illinois State Dental Society will be held in Peoria, May 12-15, 1941. The newly elected officers are: John J. Donelan, Springfield, president; J. R. Blayney, Chicago, president elect; J. Leslie Lambert, Springfield, vice president; L. H. Jacob, Peoria, secretary, and R. W. McNulty, Chicago, treasurer.

L. H. JACOB, *Secretary,*
Jefferson Building,
Peoria.

MINNESOTA STATE DENTAL ASSOCIATION

THE fifty-eighth annual session of the Minnesota State Dental Association will be held in the Municipal Auditorium, Minneapolis, February 25-27, 1941.

L. M. CRUTTENDEN, *Secretary,*
498 Lowry Medical Arts Bldg.,
St. Paul.

OHIO STATE DENTAL SOCIETY

THE next meeting of the Ohio State Dental Society will be held at the Netherland Plaza Hotel, Cincinnati, November 25-27.

VAN B. DALTON, *President,*
116 Garfield Place,
Cincinnati.

VIRGINIA STATE DENTAL ASSOCIATION

THE next annual meeting of the Virginia State Dental Association will be held at the Chamberlain Hotel, Old Point Comfort, May 5-7, 1941.

J. E. JOHN, *Secretary,*
Medical Arts Bldg.,
Roanoke.

BOARD OF DENTAL EXAMINERS OF CALIFORNIA

THE next examination by the Board of Dental Examiners of California for license to practice dentistry and for license to practice dental hygiene in California will be given in San Francisco, commencing December 16, at the College of Physicians and Surgeons, College of Dentistry, San Francisco, and at the University of California, College of Dentistry, San Francisco. All credentials must be in the office of the secretary at least twenty days prior to the date of examination. Address all communications to Kenneth I. Nesbitt, Secretary, Board of Dental Examiners of California, Room 203, 515 Van Ness Ave., San Francisco.

STATE BOARD OF REGISTRATION AND EXAMINATION IN DENTISTRY OF NEW JERSEY

THE State Board of Registration and Examination in Dentistry of New Jersey will hold its annual examinations, commencing December 9 and continuing for five days thereafter. On application to the secretary, a copy of the requirements and rules, instruction sheet and preliminary application blank will be sent. Any person desiring to apply as a candidate must file the preliminary application blank, together with the examination fee of $25, on or before March 15 for the succeeding June examinations or before September 1 for the succeeding December examinations.

WALTER A. WILSON, *Secretary,*
148 West State St.,
Trenton.

DENTAL COUNCIL AND EXAMINING BOARD OF THE COMMONWEALTH OF PENNSYLVANIA

THE Dental Council and Examining Board of the Commonwealth of Pennsylvania will conduct examinations in Philadelphia and Pittsburgh, December 10-14. For information and application blanks, address the Department of Public Instruction, Bureau of Professional Licensing, Dental Division, Harrisburg, or

REUBEN E. V. MILLER, *Secretary,*
61 North Third St.,
Easton.

SOUTH DAKOTA BOARD OF DENTAL EXAMINERS

THE South Dakota State Board of Dental Examiners will hold its next examination at the Carpenter Hotel, Sioux Falls, January 24-27, 1941. Applications should be in the hands of the secretary ten days before the date of the meeting. For further information, address

C. H. BOYDEN, *Secretary,*
Mitchell.

STATE OF WISCONSIN BOARD OF DENTAL EXAMINERS

THE Wisconsin Board of Dental Examiners will hold its next meeting at the Marquette Dental School, Milwaukee, to examine applicants for license to practice dentistry and dental hygiene December 16-20. Applications and required fee must be in the hands of the secretary not later than December 10. Address all communications to

S. F. DONOVAN, *Secretary,*
Tomah.

AMERICAN DENTAL HYGIENISTS' ASSOCIATION

THE next annual meeting of the American Dental Hygienists' Association will be held in Cleveland, Ohio, September 9-13, with headquarters at the Hotel Carter.

A. REBEKAH FISK, *Secretary,*
Walter Reed Gen. Hospital,
Washington, D. C.

EXAMINATION FOR APPOINTMENT IN THE DENTAL CORPS OF THE NAVY

A COMPETITIVE examination to select candidates for appointment in the Dental Corps of the Navy will be held December 2 at the Naval Medical School, Washington, D. C., Naval Training Station, Great Lakes, Ill., and Naval Training Station, San Diego, Calif. A candidate for appointment in the Dental Corps must be a citizen of the United States, between 21 and 32 years of age at the time of appointment, and a graduate of a standard dental college. A circular which contains full information relative to the Dental Corps and describes the method of making application for appointment can be obtained from the Bureau of Medicine and Surgery, Navy Department, Washington, D. C.

TO DIRECTORS—SUPERVISORS OF DENTAL PROGRAMS:

IN collaboration with the Bureau of Public

Relations of the American Dental Association, the New Jersey State Department of Health will present a unique dental health education exhibit. It is proposed to collect health education material from all available sources in the United States and Canada. If this effort is successful, persons interested in dental health education programs can, in one booth, obtain a bird's-eye view of present-day efforts to disseminate authentic dental health information to the public.

Please send to J. M. Wisan, New Jersey State Department of Health, Trenton, N. J., before August 1, a list of all the material that you have on hand. Then plan to send actual copies to Cleveland. Please note that the actual material is to be sent to Dr. Wisan at the convention headquarters, Room 1241, Hotel Statler, in time to reach Cleveland Saturday, September 7.

J. LYNN MAHAFFEY, M.D.,
Director of Health.

UNITED STATES PATENTS APPLICABLE OR PERTAINING TO DENTISTRY ISSUED DURING JUNE AND JULY 1940

June 4

No. 2,203,089, GEORGE M. HOLLENBACK. Dental device.

No. 2,203,226, RUDOLF KLICKA. Artificial denture.

June 11

No. 2,203,891, GEORGE HENRY BURTENSHAW. Denture demonstrating apparatus.

No. 2,204,235, DONALD D. SHELTON. Anti-thumb sucking device.

No. 2,204,295, ROBERT H. BROCKMAN. Dental pulp tester.

June 18

No. 2,204,809, JAMES S. MILLER and CARL RICHARD WALLER. Method and means for use in dentistry.

June 25

No. 2,205,488, ALBERT W. MERRICK. Method of making molded articles.

No. 2,205,775, JOHN HENCZ. Indicating device.

No. 2,205,926, JOSEPH E. KOVATS. Bite gage.

No. D-121,210, WINFRED LAMBDIN. Design for a color guide unit for artificial teeth.

No. D-121,221, WALTER O. MAITLAND. Design for a dentist's anvil.

July 2

No. 2,206,502, HAROLD A. HEILIGMAN. Shaped material for casting dentures.

No. 2,206,542, ERNEST FRANKLIN ARNOLD. Denture brush.

No. 2,206,726, ROBERT L. LASATER. Rubber toothbrush.

July 9

No. D-121,437, GILBERT E. HADDEN. Design for a toothbrush handle.

July 16

No. 2,207,953, GRACE SUMMERBELL. Dental floss holder.

No. 2,208,013, CHESTER A. BAKER. Brush for dental plates.

No. 2,208,031, WILLIAM J. HOOPER. Cleaning spray.

No. 2,208,032, WILLIAM J. HOOPER. Dental cleaning spray.

No. D-121,506, JULIUS M. DAVIS. Design for a toothbrush.

No. D-121,519, CONRAD D. MASTRUD. Design for a toothbrush or the like.

July 23

No. 2,208,633, JAY A. HEIDBRINK. Anesthetizing apparatus.

No. 2,208,967, EGON ELÖD. Tooth filling material.

No. 2,209,173, ALLIE YOUNG RUSSELL. Toothbrush.

No. 2,209,294, GEORGE E. FROELICH. Mobile dental unit.

July 30

No. 2,209,381, HERBERT R. BERGER. Dental casting apparatus.